

Annual Report

**Salinity Sampling in Biscayne Bay
(2009-2010)**

Biscayne National Park

**A Report to the United States Army Corps of Engineers
for the Monitoring and Assessment Plan of the
Comprehensive Everglades Restoration Plan
for RECOVER Assessment Team Southeast Estuary Subteam**

July 11, 2011

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Abstract:

South Florida has two distinct hydrological seasons, which directly affect salinity in Biscayne Bay. The wet season occurs from June through October and the dry season occurs from November through May. During the 2009-2010 hydrologic year the highest individual salinity values were observed in the late dry season in all years and for all sites within central and southern Biscayne Bay, while the highest average salinity occurred in the dry season. This pattern is the same in the entire data set for all years. Spatially, salinity along the mangroves of the western shoreline is very different from salinity within the network further offshore. Sample sites along the shoreline exhibit the highest and the lowest salinity values and the greatest variation (e.g., sites along the shoreline in the mangroves 14, 22, 28, 40, 56, 62, B6, B8, C2), followed by the sites the next furthest distance offshore. Sites north of Convoy Point are different from those in the southern sounds. The southern sounds (Site 20 at the Turkey Point channel headpin, and south not including Caesar's Creek site 10) exhibit much higher overall salinity and much lower variation than stations to the north. Along the mangrove sites salinity variation is higher in sites remote from canal mouths than in sites presumably directly affected by canal inflow from major canals. The lowest average salinity in the data set occurs between Black Point and Princeton Canal. Seasonal salinity differences can be observed to some extent at all sampling sites, with nearshore sites exhibiting the greatest variability between seasons. Wet season salinity values vary the most, with the largest variations occurring at sites located near the coastline. Offshore salinity measurements are less influenced by freshwater input and vary only slightly between seasons. Eight months met the estuarine restoration criteria of CERP in Biscayne Bay.

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1.0 Introduction

1.1 Introduction and Background

This document is the annual report on salinity in Biscayne Bay, Florida for 2010. This project is part of the Southern Coastal Systems Module of RECOVER for the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan (MAP) program. This report covers the water year 2009/2010 and provides trends for the period 2004-2010 for Biscayne Bay, Card Sound, Barnes Sound and Manatee Bay. This report also evaluates restoration targets for Biscayne Bay and Manatee Bay.

Biscayne Bay is the largest estuary on the southeast coast of Florida, comprising 428 square miles. Average natural depth has historically ranged from one to three meters, however modern average depth ranges from three to four meters (SFWMD, 1995; Harlem, 1979) (**Figure 1.1-1**). Biscayne Bay is generally divided into three sections, North Bay, Central Bay and South Bay, based on hydrodynamic, geographical, and oceanic characteristics (van de Kreeke and Wang, 1984; SFWMD, 1995). North Bay extends from Dumfoundling Bay at the Broward/Miami-Dade County line south to Rickenbacker Causeway. Central Bay extends from Rickenbacker Causeway south to Black Point. South Bay is the area from Black Point to Manatee Bay and includes Card Sound, and Barnes Sound.

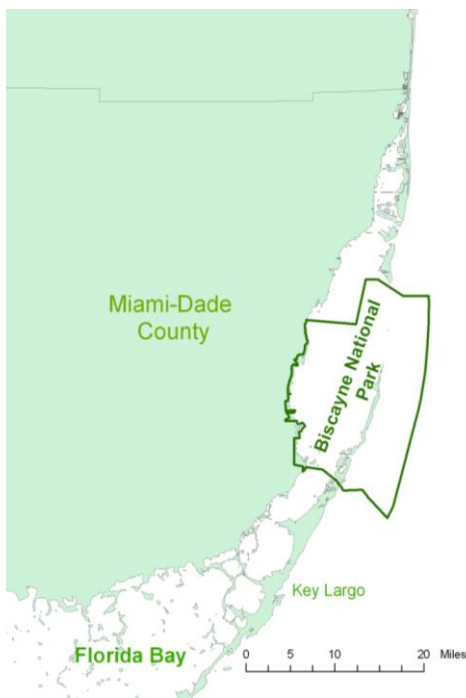


Figure 1.1-1: Location map of Biscayne Bay.

The altered Everglades drainage patterns and intense urban development in the Miami-Dade area has contributed to a loss of estuarine conditions and a transition of Biscayne Bay to a marine lagoon. Freshwater inflow to Biscayne Bay is controlled by a system of canals where the primary canals are operated by the South Florida Water Management District (SFWMD) and a secondary system is operated by Miami-Dade County. This system of canals causes fluctuation in salinity, which has resulted in large-scale ecological degradation in the Bay. One of the goals of CERP is to restore historical freshwater flows to the Bay and eliminate pulsed freshwater delivery along the Bay's southwestern shore. The goal of the MAP is to monitor salinity in the area of Biscayne Bay affected by the CERP. This project was identified by the Evaluation Team, Southern Estuaries subteam of RECOVER (Restoration Coordination and Verification), now known as the Southern Coastal Systems team. This project is intended to evaluate changes due to local CERP projects such as the Biscayne Bay Coastal Wetlands Project, L-31N Seepage Management Project, C-111 Spreader Canal Project, as well as the changes due to alterations in flow due to the broader system wide CERP project. It was initiated in FY2004 to overlap with the data collection effort for the Biscayne Bay Coastal Wetlands (BBCW) Project modeling data collection effort. This was seen as a way to use the two projects to collect information more rapidly and cover more area. The sites that were chosen for the BBCW are expanded under the MAP project and are being integrated with sites in North Biscayne Bay that are sampled by Miami-Dade County Department of Environmental Resources Management (DERM).

This project's objectives are to:

- 1) Continue monitoring salinity, conductivity, temperature and depth at all agreed upon stations.
- 2) Provide this quality assured data to other scientists and managers via the DASR on CERPZone or via the NPS websites,
- 3) Establish reference conditions (document temporal and spatial variability of salinity in the western near shore region of Biscayne Bay),
- 4) Determine the status and trends of a key variable of the Conceptual Ecological Model (CEM),
- 5) Provide data for evaluation of the MAP Performance Measures and review for the Systems Status Report.

A primary component affecting southern Biscayne Bay is the BBCW Project, whose main goals are to rehydrate coastal wetlands that are currently drained by the canal system, as well as to redistribute freshwater flow to southern Biscayne Bay from several sources. This restoration project is expected to profoundly alter salinity within the Park, especially in nearshore habitats along the mainland coast (Serafy *et al*, 2001). Other components of CERP, including upstream redirection of water, are expected to have equally profound effects on salinity in Biscayne Bay. While the final outcome of the CERP is difficult to forecast, understanding current salinity as well as documenting changes in salinity are important to adaptive assessment and to understanding ecological changes resulting from restoration.

The collection of salinity data in Biscayne National Park is currently funded by the CERP- MAP, although portions of this project have been in existence since the early 1990s. Numerous governmental agencies have participated in the development and design of this current project including Miami-Dade County Department of Environmental Resource Management (DERM), National Oceanographic and Atmospheric Administration (NOAA), the SFWMD, and the United

States Army Corps of Engineers (ACOE). Instruments and sites for salinity analysis were also funded by the SFWMD to gather data regarding salinity changes with respect to the minimum flows and levels for water delivery requirements of the State of Florida. Data from the earlier ACOE project were originally used to develop a two dimensional hydrodynamic model as part of the Biscayne Bay Feasibility Study in the late 1990s, and more recently to improve and re-calibrate this model to a three dimensional (including depth stratification) hydrodynamic model as part of the CERP BBCW (Brown *et al.*, 2003). All data collected are being used to describe current conditions in the bay prior to changes in water flow and in conjunction with biological projects also funded by the MAP. The data are being made readily available by uploading it to the South Florida Natural Resources Center database (Data ForEVER) and subsequently submitting it to the South Florida Water Management District for inclusion in their CERP and DBHydro databases. In the mean time, data is being loaded onto the CERP zone Data Access, Storage and Retrieval (DASR) website.

BISC staff worked in conjunction with SFWMD and the U. S. Army Corps of Engineers to review the information available and determine the need for optimization of monitoring locations. After compiling and reviewing this information it, was vetted with scientists from the University of Miami Rosenstiel School of Marine and Atmospheric Sciences (RSMAS), NOAA- National Marine Fisheries Service (NMFS), and the NOAA- Atmospheric and Oceanographic and Meteorological Laboratory (AOML) to determine how well the current and proposed sites fit the needs of the biological community using the data (**Appendix I**). Sites were reviewed for their proximity to the proposed Phase I of the Biscayne Bay Coastal Wetlands Project features to ensure that the coastline was adequately covered by sampling sites. Correlations between sites were used to examine potential overlap from adjacent locations. Seasonal patterns, spatial distribution, and proximity to proposed CERP features were also reviewed when evaluating sampling site distribution. This process was constrained by the need to maintain sampling integrity and the ability to produce products such as isohaline maps and evaluation of how well salinity targets are met. These products are prepared for the Recover Southern Coastal Systems team and for use by investigators and agency personnel to provide recommendations for reconfigured sampling locations.

2.0 Methods

2.1 Sampling Overview

There are 44 sites where data is collected within central and southern Biscayne Bay (**Table 2.1-1, Figure 2.1-1** from as far north as the southern side of the Snapper Creek Canal, and extending south to Manatee Bay and Barnes Sound. Three sites have surface reading instruments also recording at the same location. The highest concentrations of sites are located nearshore on the western mangrove zones 2, 3, and portions of 5 and 7. This area of high density sites runs South to North from C-103 to Deering Estate.. There are twenty sites in these mangrove zones, which are expected to be the first area affected by changes in freshwater delivery to the bay. Twenty four sites are located in the central area of the bay. Sites were also chosen based on their proximity to special interest areas, such as Black Point, Turkey Point, Barnes Sound and Manatee Bay. These areas have special characteristics related to their hydrology and proximity to key environmental concerns or changes in water flow. Some of these sites were added in response to the need to overlap with

biological sampling in the respective areas. All sites are divided into 8 zones, based on geographic location, which are retrieved tri-weekly.

The new sampling design is expected to provide data to better assess downstream effects of the Biscayne Bay Coastal Wetlands (BBCW) Project on nearshore salinity regimes. The new design also provides continuous salinity data to Biscayne Bay modeling efforts. The new site locations are intended to fill spatial data gaps in the network and capture salinity conditions at select sites. This will allow better definition of salinity in the nearshore mangrove sites. The optimization of monitoring locations was carried out from May 2010 through July 2010. Sites that were set to be terminated were ended by double deploying a newly calibrated sonde with the previously deployed sonde. This allowed overlap of readings with a newly calibrated instrument in order to determine drift of the previous instrument. This final data was then entered into the DataforEver data base for reference. New sites were deployed over a period of three months. The period of record for sample sites area shown in Table 2.1-2.

During optimization an attempt was made to improve the usefulness of the sites for kriging. The maps were created using the kriging method in Arcmap version 9.3. This method uses interpolation, which predicts unknown values from data observed at known locations (Journel *et al.*, 1981) This method uses variogram to express the spatial variation, and it minimizes the error of predicted values, which are estimated by spatial distribution of the predicted values. Salinity was collected in 15 minutes intervals and then averaged for the entire month. Data from all the sites were used in this interpolation. Data is viewed using kriging to develop isohalines in ArcMap GIS and map these by month, for wet season-dry season, and by year to better visualize the data. These isohaline plots are useful for comparisons with biological data and for presentations. The validity of the krieged maps depend upon the locations and number of sites to be included in the analysis. During reconfiguration some sites were added to provide better coverage for kriging, while some sites were removed that were deemed unnecessary. Sites were removed after the end of the dry season and new sites were added during this period as quickly as possible.

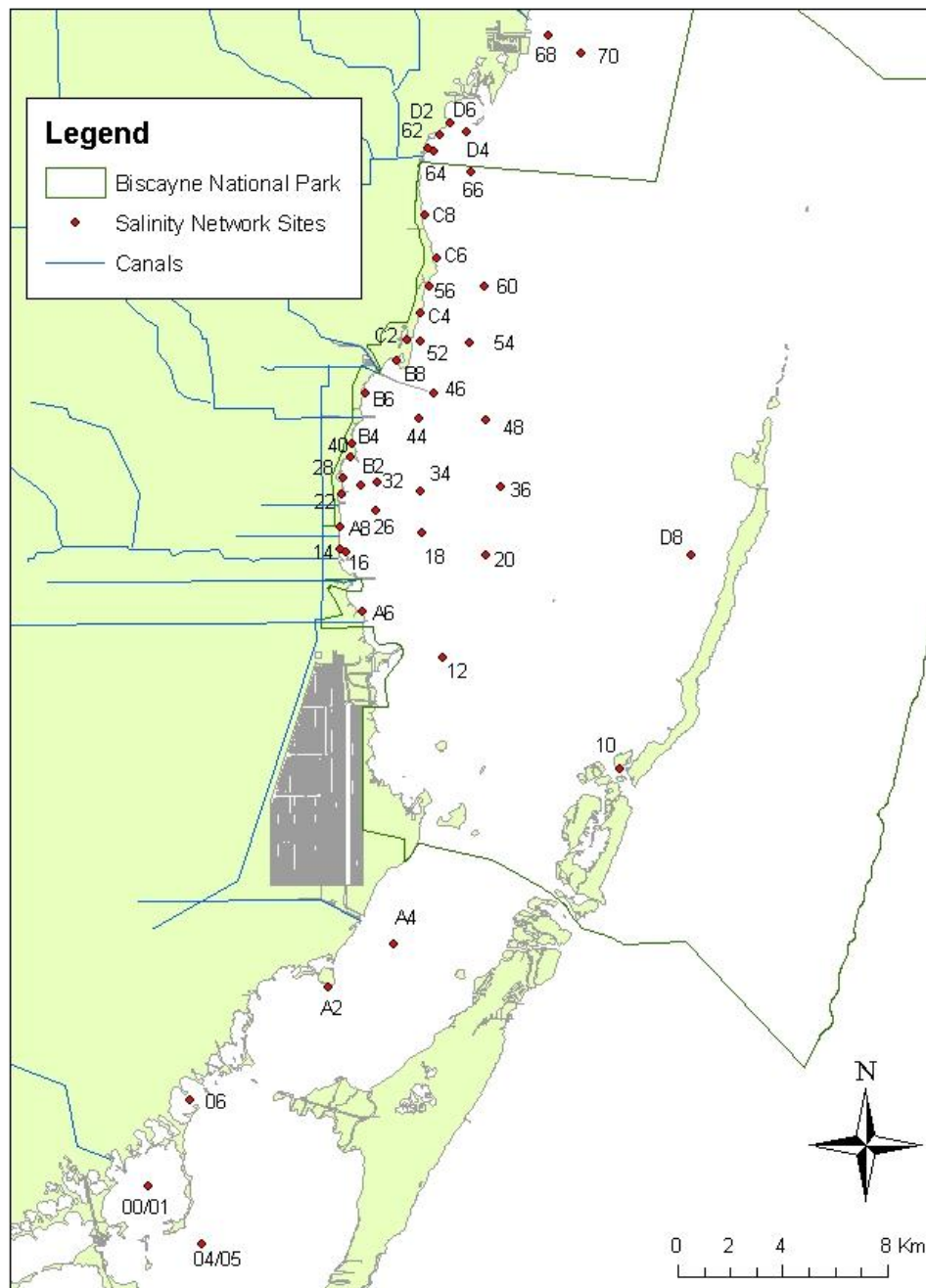


Figure 2.1-1: Map showing all the sites in project.

Table 2.1-1: Listing of all sites with GPS coordinates and location relative to the water column.

Site ID's	Latitude	Longitude	Instrument Type	Deployment
00	25.253	-80.414	Bottom	Horizontal
01	25.253	-80.414	Surface	Vertical
04	25.233	-80.394	Bottom	Horizontal
05	25.233	-80.394	Surface	Vertical
06	25.283	-80.398	Bottom	Horizontal
10	25.3968	-80.2340	Bottom	Vertical
12	25.436	-80.301	Bottom	Horizontal
13	25.436	-80.301	Surface	Vertical
14	25.47361	-80.34003	Bottom	Horizontal
16	25.47264	-80.33777	Bottom	Horizontal
18	25.47878	-80.30886	Bottom	Horizontal
20	25.47103	-80.28453	Bottom	Vertical
22	25.49242	-80.33911	Bottom	Horizontal
26	25.48681	-80.3265	Bottom	Horizontal
28	25.49844	-80.33875	Bottom	Horizontal
32	25.49633	-80.32548	Bottom	Horizontal
34	25.49353	-80.30908	Bottom	Horizontal
36	25.49472	-80.27836	Bottom	Horizontal
40	25.50533	-80.33577	Bottom	Horizontal
44	25.51886	-80.3094	Bottom	Horizontal
46	25.52728	-80.30406	Bottom	Vertical
48	25.518	-80.284	Bottom	Horizontal
52	25.54539	-80.30869	Bottom	Horizontal
54	25.545	-80.29	Bottom	Horizontal
56	25.56444	-80.30531	Bottom	Horizontal
60	25.56428	-80.28417	Bottom	Horizontal
62	25.61225	-80.30583	Bottom	Horizontal
64	25.61136	-80.30353	Bottom	Horizontal
66	25.60408	-80.28922	Bottom	Horizontal
68	25.65128	-80.25958	Bottom	Horizontal
70	25.645	-80.247	Bottom	Horizontal
A2	25.3223	-80.3451	Bottom	Horizontal
A4	25.33679	-80.32008	Bottom	Horizontal
A6	25.45211	-80.3313	Bottom	Horizontal
A8	25.48128	-80.3397	Bottom	Horizontal
B2	25.49547	-80.332	Bottom	Horizontal
B4	25.51011	-80.3353	Bottom	Horizontal
B6	25.52728	-80.3299	Bottom	Horizontal
B8	25.53853	-80.3178	Bottom	Horizontal
C2	25.54586	-80.3137	Bottom	Horizontal
C4	25.55506	-80.3088	Bottom	Horizontal
C6	25.57425	-80.3026	Bottom	Horizontal
C8	25.58897	-80.307	Bottom	Horizontal
D2	25.61678	-80.3013	Bottom	Horizontal
D4	25.61767	-80.2908	Bottom	Horizontal
D6	25.62097	-80.2974	Bottom	Horizontal
D8	25.47061	-80.206	Bottom	Horizontal

Table 2.1-2: Sites Period of Record.

Site	Period of Record	
00	2004	to current
01	2004	to current
04	2004	to current
05	2004	to current
06	2004	to current
10	2004	to current
12	2004	to current
13	2004	to current
14	2004	to current
16	2004	to current
18	2004	to current
19	2004	to 06/23/2010
20	2004	to current
22	2004	to current
24	2004	to 05/17/2010
26	2004	to current
28	2004	to current
30	2004	to 05/17/2010
32	2004	to current
34	2004	to current
35	2004	to 06/23/2010
36	2004	to current
37	2004	to 06/23/2010
40	2004	to current
42	2004	to 05/17/2010
44	2004	to current
45	2004	to 06/07/2010
46	2004	to current
48	2004	to current
50	2004	to 06/16/2010
52	2004	to current
54	2004	to current
55	2004	to 06/07/2010
56	2004	to current
58	2004	to 06/16/2010
60	2004	to current
61	2004	to 07/21/2010
62	2004	to current
64	2004	to current
66	2004	to current
67	2004	to 07/21/2010
68	2004	to current
70	2004	to current
A2	2010	to current
A4	2011	to current
A6	2010	to current
A8	2010	to current
B2	2010	to current
B4	2010	to current
B6	2010	to current
B8	2010	to current
C2	2010	to current
C4	2010	to current
C6	2010	to current
C8	2010	to current
D2	2010	to current
D4	2010	to current
D6	2010	to current
D8	2010	to current

2.2 Location and Deployment

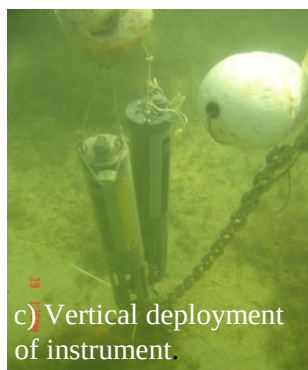
There are currently 44 sites recording benthic data. Originally there were ten sites with both benthic and surface instruments deployed. However due to optimization of the data, the majority of these surface instruments were removed and currently there are now only three sites with surface instruments deployed. Most sites, including the sites with surface buoys, have bottom meters deployed horizontally (**Figure 2.2-1 b**). Only sites 10, 20 and 46 are deployed vertically (**Figure 2.2-1 c**), to simplify deployment. At those sites where there is horizontal deployment, the instrument is locked onto a concrete paver fitted with two eyebolts. At vertical deployment sites the U-bolt of the instrument cage is attached to an eye-pin cemented into the bay floor using a brass padlock. In case of possible lock failure, a heavy-duty cable tie is fitted between the U-bolt and eye-pin for extra support.

The three sites within the bay that are also recording data approximately 0.25 m below water surface via instruments are placed within a surface buoy co-located with a benthic site (**Figure 2.2-1 a**) using YSI Environmental 6600 Series instruments. The instruments deployed on the surface are located in buoys that are specifically fabricated for this application. They are built by modifying a normal can buoy using two four inch diameter PVC pipes running through the buoy. This configuration allows for the simultaneous deployment of two instruments making overlapping readings used in Quality Assurance/Quality Control (QA/QC) analysis of the data. Benthic instruments are all double deployed for over lapping data that is also used in Quality Assurance/Quality Control (QA/QC) analysis as well.

A portable weather instrument is used to denote deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Once all instruments have been deployed within a zone, there is a waiting period of a minimum of one-hour before retrieving the old instrument. The waiting period allows a minimum of four-consecutive overlap readings. The old instruments to be retrieved are then collected, with all relevant environmental data collected and the new instruments left on site.



a) YSI meter deployed



c) Vertical deployment of instrument.



b) Horizontal deployment of instrument.

Figure 2.2-1: Deployment of YSI meter.

2.3 Calibration and Data Collection

The YSI Environmental 6600 Series instruments are calibrated after each retrieval. This is done twice, first as a dirty post calibration and second after being cleaned prior to being sent into the field. During calibration, the temperature and specific conductivity of the seawater standard are used to calibrate the instrument are recorded. Once calibrated, the instrument is set up in unattended mode with the file name corresponding to site number, instrument number, and date of deployment. Specific calibration procedures are described below.

The retrieved meters are brought back to the lab for uploading data and post calibration. The sensor is placed in the same conductivity standard used to calibrate the instrument. Temperature, specific conductivity, depth, and battery levels are recorded onto the calibration sheet, which is later entered into the computer and associated with that particular filename and site. Cell constants are also reviewed and noted on the calibration sheet to ensure there was no instrument sensor variation between calibrations. Post calibration is done twice: once prior to the meter being cleaned of biofouling and then once the meter has been cleaned. The meter is then recalibrated and if necessary, set up to record for the next set of sites. For additional details on calibration and post-calibration procedures, see **Appendix II: QA/QC Plan**.

Temperature. The temperature probe is checked during calibration using a laboratory traceable NIST Celsius thermometer. A temperature reading must be within ± 0.15 degrees Celsius to be acceptable. If the check does not meet these requirements, the sonde will be checked. If the sonde still does not prove correct, the associated data will be flagged and the unit will then be sent to the

manufacturer for service. The temperature probe is also checked by the factory during any maintenance and service of the instrument.

Conductivity. The conductivity probe is calibrated by filling the calibration cup with a traceable YSI conductivity standard of 50 ms/cm and is adjusted to that value. The calibration is accepted if the sonde reads within $\pm 0.5\%$ of the true value of the standard. If the reading does not meet these limits, the problem will be determined and corrected. **Note:** Instruments measure conductance and temperature, from these readings the meter then calculates specific conductance and salinity. Conductivity is calibrated using one point. The YSI 6600 meets or exceeds advertised conductivity specifications with a single point calibration. However, a check is done with a solution of low specific conductivity to ensure accurate calibration throughout the possible data range and is noted on the Calibration Sheet. In the event the check does not read the correct value, the meter is recalibrated.

Depth. Depth is determined using a pressure sensor. Barometric pressure, taken from a Princo Nova mercury barometer located in the laboratory is recorded on the calibration sheet and the depth is calibrated to 0 meters. Atmospheric pressure is noted to ensure the meters are responding throughout the expected measurement range. If an incorrect reading is observed, the sensor will be cleaned and rechecked. If the problem is not corrected by cleaning, the manufacturer is contacted for instructions/recommendations.

Weather Data. A portable weather instrument (Kestrel Pocket Weather Tracker) is used to record deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Wind direction, wave height and the meter identification number are also recorded onto field data sheets at each deployment site. All the data collected at deployment sites is entered into a database along with information about the calibration of each instrument used at every site. This facilitates QA/QC for an individual data sonde's repetitive malfunction due to site-specific or weather-related conditions. Time on the weather instrument is standardized to Eastern Standard Time at the beginning of each deployment trip with the atomic clock in Boulder Colorado.

2.4 Data downloading and Post Calibration

Using YSI Endeco-EcoWatch software, the raw field data is downloaded to a local computer as a text file and submitted to the Everglades National Park DataForEver Database. This avoids potential errors from manipulating data to adjust format and make data corrections outside of the database. Only the actual data from the deployment is uploaded to the database. The readings before the deployment and after retrieval are not uploaded into the database. The weather and site field data collected at deployment sites is entered into an Access database along with information about the calibration of each instrument used at every site.

Once the data file is uploaded to the South Florida Natural Resource Center's Database (DataForEver), it is reviewed for outliers and instrument malfunctions. In the event that there are single outlier data points in which one salinity data point suddenly decreases over $\pm 5\%$ around a linear regression of the data (to find outliers where the salinity increases are anomalies), canal discharge and rainfall measurements are checked to determine whether they would be the cause for

the sudden change in salinity value. If a large rainfall or canal discharge was recorded a few days prior to the outlying data point, the data point will be retained.

Otherwise, the point is deleted. When data points from surface sites fall below the depth of zero, it is assumed that the meter came out of water during those readings so these data are disregarded unless these phenomena occurred at other instrument sites. If the pattern is the same at other sites, with depth values apparently appearing slightly above water surface, it is assumed that this was an atmospheric pressure phenomenon and these values are left in the data set.

Once the data file is QA/QC'd, null values are entered into empty time slots, and the data is run through Estimated Linear Interpolation. It is assumed that a newly deployed instrument is reading correctly and that drift could have occurred in the retrieved instrument. Using DataForEver database, the data are plotted to see whether the overlap in readings corresponds to the same pattern of increase/decrease in salinity. If the readings from the previous file match or follow the same pattern as the file that follows, the database uses the first reading of the deployed meter file to interpolate the drift that occurred between the first reading of the retrieved meter file and the last reading of the retrieved meter file. If the final reading of the previous retrieved meter file and the first reading of the deployed meter file do not match or follow the same pattern, the first (dirty) post-calibration reading is used to determine the linear interpolation. After 'Estimation Linear Interpolation' is completed, the data is validated. Data Validation performs two vital roles, it removes data that only the group collecting the data could identify as invalid, and it verifies a consistent data set that is verified to within the specified parameters and then can be made available to the public.

3.0 Data Analysis and Results

3.1 Annual Results 2009-2010

3.1.1 Salinity November 2009 - October 2010

The annual average water year salinity as recorded by this network between November 2009 and October 2010 was 26.4 practical salinity units (psu) (**Table 3.1.1-1**). The lowest average monthly salinity by site for the time period was 8.8 psu (western mangroves site between Fender Point and Black Point, site B6) and the highest average monthly salinity was 43.6 psu (Turkey Point headpin) (**Table 3.1.1-1**). Lowest average monthly salinities were found at the inshore sites located between C-1 (Black Creek) and C-103 (Mowery Canal) canals. Slightly higher salinities were noted at the nearshore areas north of Black Point. Sites with the highest average salinities were located furthest offshore, approaching seawater levels. Site 10, located near Adams Key, exhibited the highest overall average salinity during this period (36.8 psu, $\sigma = 0.91$), due to its proximity to oceanic waters.

3.1.2 Salinity in 2009-2010

An increasing salinity trend was observed from west to east into the more ocean-influenced area of the Bay. Salinities greater than 30 psu are observed throughout the year at many sites. Southern sites south of Turkey Point have generally higher average salinity than the rest of the network. Adams Key (Site 10), which is directly influenced by the ocean due to its location, is the only sampling site with marine salinity (35 psu) throughout the water year.

Table 3.1.1-1: Monthly average salinity in psu for all sites in the Salinity Monitoring Network.

Site	11/09	12/09	01/10	02/10	03/10	04/10	05/10	06/10	07/10	08/10	09/10	10/10
0	29.05	25.84	25.09	25	24.97	26.39	27.69	28.38	29.35	29.15	24.75	19.57
4	30.53	28.81	27.02	27.84	26.83	26.99	28.4	31.37	32.2	31.58	31.05	22.57
6	31.42	26.73	26.54	26.56	26.65	27.21	28.76	29.09	30.68	30.48	26.68	null
10	35.65	34.47	35.3	34.6	35.24	36.18	35.71	35.75	36.75	36.32	null	33.62
12	32.02	29.47	28.81	28.24	31.07	32.08	34.55	36.28	38.42	34.35	30.22	24.63
14	23.28	19.6	23.66	21.93	23.14	15.27	22	20.6	21.9	25.97	10.01	13.72
16	25.7	22.61	26.14	24.18	25.67	19.01	23.74	23.14	23.94	28.84	13.54	16.55
18	31.68	29.89	32.14	30.2	30.31	30.94	31.44	33.23	35.43	33.44	28.59	26.2
20	34.76	32.15	33.14	32.99	33.95	33.98	36.13	36.98	40.75	43.56	37.82	28.91
22	23.19	19.18	23.08	20.7	22.29	17.3	17.43	13.95	17.64	23.15	11.75	16.02
24	24.53	19.85	22.85	19.62	21.56	18.92	22.79	null	null	null	null	null
26	28.54	24.7	27.16	24.66	26.13	26.23	29.05	27.16	30.09	29.98	20.15	21.17
28	22.95	19.19	23.09	21.65	22.56	16.77	17.95	16.94	20.98	23.97	11.46	15.73
30	23.2	19.58	22.55	20.56	22.3	17.57	22.06	null	null	null	null	null
32	28.02	24.19	26.2	24.04	25.59	24.86	26.63	25.09	28.96	28.41	19.35	20.88
34	31.24	29.35	30.64	28.99	29.8	31.25	34.4	33.33	31.64	23.68	23.24	25.25
36	34.81	32.77	32.76	32.89	33.91	33.97	35.69	36.49	37.51	37.57	33.02	30.26
40	20.81	18.28	22.33	20.7	21.38	16.48	18.86	16.43	19.51	21.96	10.97	16.77
42	20.56	17.45	19.5	17.86	19.44	15.55	17.64	null	null	null	null	null
44	28.43	25.52	27.4	null	26.23	27.76	28.27	26.97	30.49	28.82	23.34	24.19
46	28.8	25.48	27.59	25.76	25.01	null	null	25.84	29.43	30.93	22.46	24.62
48	33.16	30.93	31.7	30.87	31.46	31.19	30.96	34.97	39.62	39.58	33.1	29.45
50	28.18	23.62	25.48	22.13	22.19	23.18	25.58	20.53	null	null	null	null
52	28.15	23.44	25.85	22.4	21.66	23.31	24.14	18.71	18.86	19.83	18.26	22.61
54	30.4	27.81	29.93	27.89	27.02	29.42	29.24	29.06	33.85	32.46	26.38	24.86
56	30.71	26.17	27.85	24.9	25.2	25.64	26.63	21.73	22.87	21.45	18.96	22.26
58	30.76	26.21	27.57	24.94	23.93	25.7	27.04	21.21	null	null	null	null
60	31.14	27.79	29.29	28.25	26.97	31.07	31.11	28.94	32.28	28.34	23.82	25.71
62	31.28	27.92	28.61	27.56	26.44	26.58	26.71	24.2	30.35	28.27	19.89	23.9
64	29.5	26.94	28.58	26.99	25.99	28.23	29.78	26.43	28.22	28.48	23.14	24.62
66	33.05	30.13	31.74	32.45	32.52	30.19	32.84	31.83	34.63	26.74	21.81	26.24
68	31.49	30.19	29.85	29.89	31.78	31.59	31.91	31.16	31.91	31.78	28.06	26.36
70	34.25	31.87	32.21	32.66	33.5	34.6	35.18	35.59	36.03	34.98	31.09	28.51
A2			null	null	null	null	null	null	35.85	32.32	26.15	25.47
A4			null	null	null	null	null	null	null	null	null	null
A6			null	null	null	null	29.37	30.58	32.25	36.68	null	17.17
A8			null	null	null	null	24.22	19.62	21.07	25.7	11.85	15.55
B2			null	null	null	null	23.58	21.77	24.6	25.57	15.18	18.78
B4			null	null	null	null	17.54	14.53	18.13	23.61	null	null
B6			null	null	null	null	15.39	9.93	14.55	15.8	8.8	17.43
B8			null	null	null	null	null	null	22.55	20.7	15.91	21.25
C2			null	null	null	null	null	null	null	null	15.93	21.28
C4			null	null	null	null	null	20.06	21.64	21.05	18.56	22.53
C6			null	null	null	null	null	null	21.49	22.16	19.76	23.71
C8			null	null	null	null	null	null	25.7	25.18	19.83	23.72
D2			null	null	null	null	null	null	null	null	null	24.11
D4			null	null	null	null	null	null	null	null	null	25.53
D6			null	null	null	null	null	null	null	null	null	23.73
D8			null	null	null	null	null	null	null	null	null	null

3.2 Monthly Summaries

Each month is summarized using the kriged GIS maps found in **Appendix IV**. Each map shows the interpolated average salinity in Biscayne Bay for the specific month. Summary statistics by month area listed in Table 3.2-1.

Table 3.2-1: Salinity summary statistics (psu) by month for all sites in the Salinity Monitoring Network.

Salinity Monitoring Network (psu)	Average Salinity	Minimum Salinity	Maximum Salinity	Standard Deviation
11/09	29.1	20.6	35.7	4.09
12/09	26.0	17.5	34.5	4.61
01/10	27.6	19.5	35.3	3.69
02/10	26.2	17.9	34.6	4.43
03/10	26.7	19.4	35.2	4.29
04/10	26.1	15.3	36.2	6.17
05/10	27.0	15.4	36.1	5.80
06/10	26.1	9.9	37.0	7.22
07/10	28.5	14.6	40.8	6.94
08/10	28.5	15.8	43.6	6.02
09/10	21.5	8.8	37.8	7.34
10/10	22.9	13.7	33.6	4.47

November 2009

In November 2009, monthly salinities ranged from 20.6 to 35.7 psu with an average of 29.1 psu ($\sigma = 4.09$) (**Tables 3.1.1-1 and 3.2-1**). Average monthly salinity ranged from 20.6 to 23.2 psu in the nearshore sites between C-1 Canal and Mowry Canals, 28 to 30 psu just north of Black Point, and over 30 psu around Deering Estate with 17 sites having average monthly salinity above 30 psu (**Appendix IV, Figure 3.2-1**). Adams key was the only site with salinity above 35 psu. Average monthly salinity in Manatee Bay and Barnes Sound was between 29 and 30.5 psu. Average salinity in the monitoring area was an average of 6 psu higher in November 2009 than in the previous year.

December 2009

Average salinity recorded this month was less than 3 psu higher than the average salinity in November 2009 with a value of 26 psu ($\sigma = 4.61$) (**Table 3.2-1**). The minimum value was 17.5 psu and the maximum value was 34.5 psu. Salinity ranged between 17.5 and 19.9 psu the area between Princeton and Mowry Canals (**Appendix IV, Figure 3.2-2**). December was the first month of the water year 2009-20010 with estuarine conditions (less than 20 psu) in Biscayne Bay. Salinities increased to 23 between North canal and the sites just North of Black Point. Salinities increased to above 30 psu at the mid bay sites. The highest salinity was found on Adams Key with a salinity of 34.5 psu reflecting ocean influence. Average monthly salinity in Manatee Bay and Barnes Sound were lower than the values measured in November, ranging between 25 and 29 psu.

January 2010

Average monthly salinity was 27.6 psu ($\sigma = 3.69$) (**Table 3.2-1**) with lowest salinity near Fender Point (19.5 psu) and highest at Adams Key (35.3 psu) (**Table 3.1.1-1**). Average monthly salinity ranged between 20 and 25 psu between Mowry and C-1 Canals (**Table 3.1.1-1 and Appendix IV**,

Figure 3.2-3). During this period, all the sites located north of Black Point had salinities above 25 psu. Average monthly salinity ranged between 25 and 27 psu in the Manatee Bay and Barnes Sound area.

February 2010

Average monthly salinity was 26.2 psu ($\sigma = 4.43$) (**Table 3.2-1**). Average monthly salinity ranged from 17.9 to 25 between Convoy Point and sites 56 located north of Black Point. Salinity increased to over 30 psu moving offshore with the highest average monthly salinity recorded at Adams Key (34.6 psu). (**Table 3.1.1-1 and Appendix I, Figure 3.2-4**). The site near Fender Point exhibited the lowest average salinity. Salinities in Manatee Bay and Barnes Sound were almost the same than the values in February 2009 with salinities of 25 and 27.8 psu. The monthly salinity for this month was lower than the salinity in February 2009 (30.7 psu).

March 2010

In March 2010, average monthly salinities were almost the same than February 2010 (**Appendix IV, Figure 3.2-5**). The lowest salinity, 19.4 psu, was measured in near Fender Point (**Table 3.1.1-1**). Salinities were under 25 psu from Mowry Canal to sites located between C- 100 and Black Point. Salinity increased offshore to approximately 33 psu in the mid bay region. The highest salinity was 35.2 psu on the site at Adams Key. The average monthly salinity was 26.7 psu ($\sigma = 4.29$) (**Table 3.2-1**).

April 2010

Average monthly salinity in April 2010 was 26.1 psu ($\sigma = 6.17$) (**Table 3.2-1**). Minimum average salinity for this month was 15.3 psu, site near Mowry Canal. All the western mangrove sites located between Mowry and Princeton Canal had salinities below 20 psu. This month was the first to experience estuarine conditions (less than 20 psu) in 2010. This is also the first time since 2004, April has salinities below 20 psu. Sites located Deering Estate had salinities between 26 and 28.5 psu. All the other sites throughout the bay had average salinity above 30 psu (**Appendix IV, Figure 3.2-6**). The highest salinity was measured at Adams key (36.2 psu). Manatee Bay and Barnes Sound had average salinities of 26 psu witch was 10 psu lower than April 2009. Biscayne Bay had an average salinity 11 psu lower in April 2010 than in April 2009.

May 2010

The average salinity in the Bay for May 2010 was 27 psu ($\sigma = 5.8$), which was 11 psu less than May 2009 (**Table 3.2-1**). The highest average salinity was measured at Turkey Point headpin (36.1 psu) and the lowest between Princeton and C-1 Canals (15.4 psu) (**Table 3.11-1**). An estuarine zone was present from Military to C-1 Canals with salinities less than 20 psu. This also the first time that May is experiencing estuarine conditions with usually no salinities under 30 psu. All the sites north of Black point had salinities over 23 psu (**Appendix IV, Figure 3.2-1**). Average salinity in Manatee Bay and Barnes Sound was around 28 psu.

June 2010

In June 2010, average salinity was 26.1 psu ($\sigma = 7.22$). Monthly salinity ranged between 9.9 and 37 psu (**Table 3.11-1**). Lowest average salinity was found between Princeton and C-1 Canals (**Appendix IV, Figure 3.2-8**). Highest salinity was found at Turkey Point headpin (37 psu). Salinities ranged between 14 to 19 psu from Mowry to North of Black Point. Salinities increased

moving offshore with 3 sites above 35 psu (**Table 3.1.1-1**). Average salinity in Manatee Bay and Barnes Sound ranged between 29.4 and 32.2 psu. In accordance to the optimization project, mangrove sites were stopped during this month.

July 2010

In July 2010, average monthly salinity increased to 28.5 psu ($\sigma = 6.94$) (**Table 3.2-1**). Estuarine conditions were present between Fender Point and Black Point with a lowest salinity of 14.6 psu. The highest average salinity was found at Turkey Point headpin, 40.8 psu (**Table 3.1.1-1**). Average salinity ranged between 21 to 25 psu from Convoy Point to the sites located south of Deering Estate (**Appendix IV, Figure 3.2-9**). Manatee Bay and Barnes Sound had monthly average salinities between 29.2 and 31.6 psu, Card Sound had monthly average salinity over 35 psu (**Table 3.1.1-1**).

August 2010

Average monthly salinity was the same than July with a value of 28.5 psu ($\sigma = 6.02$) (**Table 3.2-1**). Only sites 52 and B6 had salinity under 20 psu with a lowest average salinity of 15.8 psu (**Table 3.1.1-1**). All sites between the south of C-100 Canal and Military Canal had average salinities ranging from 20 to 25 psu (**Appendix IV, Figure 3.2-10**). The maximum salinity was 43.6 psu at Turkey Point headpin. Salinity increased to over 35 psu moving offshore. Barnes Sound and Card Sound had monthly average salinities between 31.6 and 32.3 psu where Manatee Bay was 29.2 (**Table 3.1.1-1**).

September 2010

In September 2010, average salinity decreased throughout Biscayne Bay with a monthly average salinity of 21.5 psu ($\sigma = 7.33$) (**Table 3.2-1**). The lowest average salinity was recorded between Princeton and C-1 Canals (8.8 psu) and the highest at Turkey Point headpin (37.8 psu) which was the only site with salinity over 35 psu (**Table 3.1.1-1**). September had the lowest salinity of the period of study. Nearshore sites located between the C-100 and North Canal had average salinity ranging from 8.8 to 20 psu corresponding to the biggest estuarine zone of the year (**Appendix IV, Figure 3.2-11**). Monthly average salinity decreased in Card Sound and Manatee Bay with salinities between 24.8 and 26.2 psu (**Table 3.1.1-1**).

October 2010

Average salinity in the bay for October was 22.9 psu ($\sigma = 4.47$) (**Table 3.2-1**), which was 4.4 psu lower than October 2009. The lowest average salinity was recorded near Mowry Canal (13.7psu) (**Table 3.1.1-1**). All the nearshore sites between Turkey Point and Black Point had salinity under 20 psu creating also an estuarine zone (**Appendix IV, Figure 3.2-13**). The highest average salinity was recorded at Adams Key (33.6 psu). Average salinity decreased in Barnes Sound and Manatee Bay with values between 19.6 and 22.6 psu. Card Sound had an average monthly salinity of 25.5 psu.

3.3 Water Year

Table 3.3-1: Salinity Site Averages by Wet/Dry Seasons and Water Year and Standard Deviation.

				Standard deviation	Standard deviation
Site	Dry Season 2009-2010	Wet Season 2010	Water Year 2009-2010	Dry Season 2009-2010	Wet Season 2010
0	26.29	26.24	26.3	1.56	4.17
4	28.06	29.75	28.9	1.33	4.04
6	27.70	29.23	28.5	1.82	1.84
10	35.31	35.61	35.5	0.61	1.39
12	30.89	32.78	31.8	2.22	5.47
14	21.27	18.44	19.9	2.97	6.46
16	23.86	21.20	22.5	2.49	6.12
18	30.94	31.38	31.2	0.85	3.83
20	33.87	37.60	35.7	1.30	5.51
22	20.45	16.50	18.5	2.53	4.32
24	21.45		21.4	2.06	
26	26.64	25.71	26.2	1.72	4.77
28	20.59	17.82	19.2	2.59	4.83
30	21.12		21.1	2.00	
32	25.65	24.54	25.1	1.43	4.33
34	30.81	27.43	29.1	1.81	4.71
36	33.83	34.97	34.4	1.13	3.22
40	19.83	17.13	18.5	2.04	4.11
42	18.29		18.3	1.67	
44	27.27	26.76	27.0	1.16	3.02
46	26.53	26.66	26.6	1.60	3.48
48	31.47	35.34	33.4	0.81	4.36
50	24.34	20.53	22.4	2.20	2.51
52	24.14	19.65	21.9	2.21	1.75
54	28.82	29.32	29.1	1.25	3.84
56	26.73	21.45	24.1	2.01	1.50
58	26.59	21.21	23.9	2.21	2.30
60	29.37	27.82	28.6	1.76	3.24
62	27.87	25.32	26.6	1.70	4.09
64	28.00	26.18	27.1	1.41	2.30
66	31.85	28.25	30.0	1.22	5.03
68	30.96	29.85	30.4	0.93	2.50
70	33.47	33.24	33.4	1.27	3.29
A2		29.95	29.9		5.00
A4					
A6	29.37	29.17	29.3	0.50	8.40
A8	24.22	18.76	21.5	1.34	5.30
B2	23.58	21.18	22.4	3.09	4.27
B4	17.54	18.76	18.1	3.96	4.57
B6	15.39	13.30	14.3	2.44	3.76
B8		20.10	20.1		2.90
C2		18.61	18.6		3.78
C4		20.77	20.8		1.53
C6		21.78	21.8		1.64
C8		23.61	23.6		2.65
D2		24.11	24.1		0.96
D4		25.53	25.5		0.78
D6		23.73	23.7		0.98
D8					
Average	26.4	25.2	25.3		
Minimum	15.4	13.3	14.3		
Maximum	35.3	37.6	35.7		
Std Dev	4.92	5.8	5.2		

3.3.1 Dry Season 2009-2010

Average dry season salinity for the 2009-2010 water year was 26.4 psu ($\sigma = 4.92$) (**Table 3.3-1**). Dry season salinity was calculated by averaging the monthly values from November 1, 2009 through May 31, 2010. There were no sites with an average salinity below 15 psu (**Table 3.3-1**). Average salinity throughout the dry season was the lowest along the shoreline from just North of Black Point, South to Military Canal (**Figure 3.3.1-1**). The sites with the highest average salinity were Adams Key with a salinity of 35.3 psu, followed by site 20 (mid-bay) with salinity of 33.9 psu. The site with the lowest average salinity was at B6, just south of Goulds Canal with a salinity of 15.4 psu. The range between minimum and maximum salinity was 19.9 psu. Salinity increases outward from the area of highest canal discharge to the north, south, and east. Salinities between 25 and 35 psu were recorded in Barnes Sound and Manatee Bay.

3.3.2 Wet Season 2010

The average 2010 wet season salinity was 25.2 psu ($\sigma = 5.8$), which was lower than the previous year's wet season (**Table 3.3-1**). Wet season average was calculated by taking the average of monthly values from June 1, 2010 through October 31, 2010. The minimum wet season salinity for all 44 sites was 13.3 psu just south of Goulds Canal. This area had the lowest salinity in both the dry and wet seasons of 2009-2010 (**Table 3.3-1**). The highest average salinity during the wet season was 37.6 at site 20 in mid-bay, which was the same value than the dry season of 2009-2010. The apparent development of a large area of high salinity in mid Bay is unusual. The range between the average minimum and maximum salinities for the wet season was 24.3 psu. Salinities throughout the wet season were the lowest along the shoreline from Mowry Canal (C-103) to Site B8 (**Figure 3.3.2-1**). The average salinity from the dry season to the wet season decreased by 1.2 psu along the western shoreline. The ranges in salinity throughout the bay are lower in the dry season than that of the wet season (**Figure 3.3.2-1**).

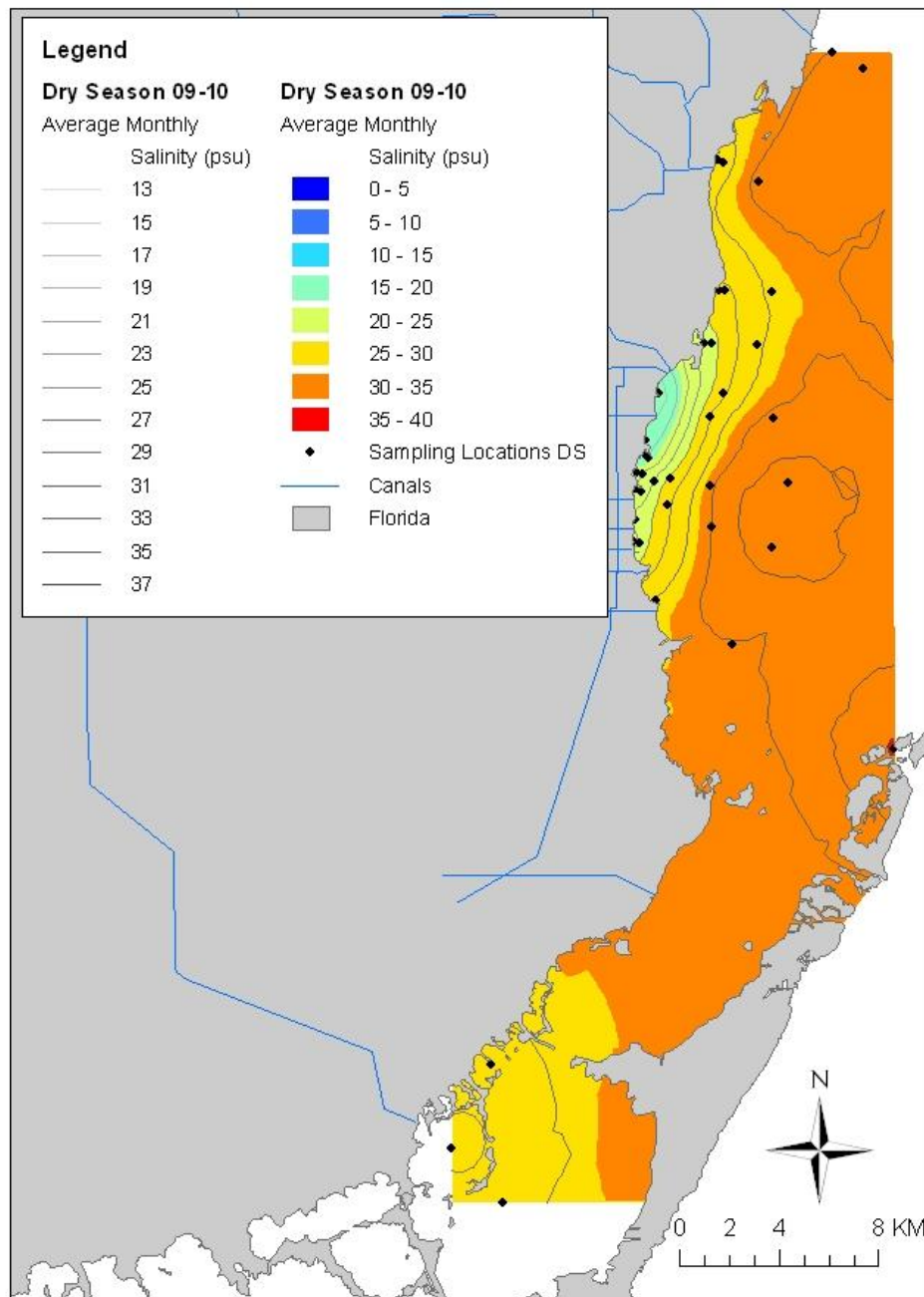


Figure 3.3.1-1: Interpolated average salinity for Biscayne Bay between November 2009 and May 2010. Data from 38 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire period. Plots show isohaline contours and salinity by data range.

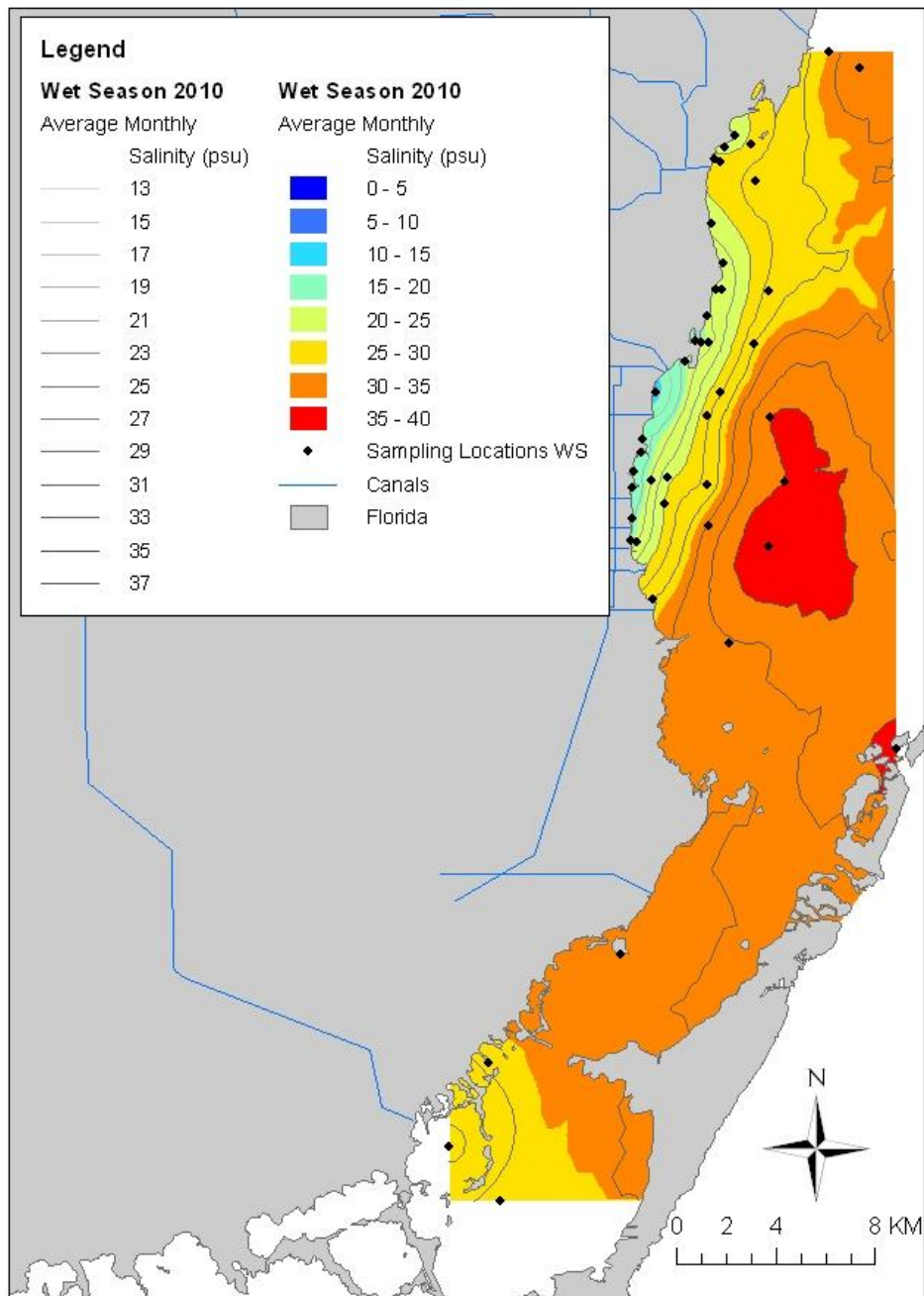


Figure 3.3.2-1: Interpolated average wet season salinity in Biscayne Bay between June 2010 and October 2010. Data from 44 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire period. Plots show isohaline contours and salinity by data range.

The annual 2010 variance is presented in Figure 3.3-1 was unusual in the development of a high salinity zone in the benthic sites in the center of the Bay during the wet season. These sites are about 6-7 feet deep (~2m). Variance in the new sites represents that same pattern as before with the highest variance along the shoreline and higher values south of Black Point.

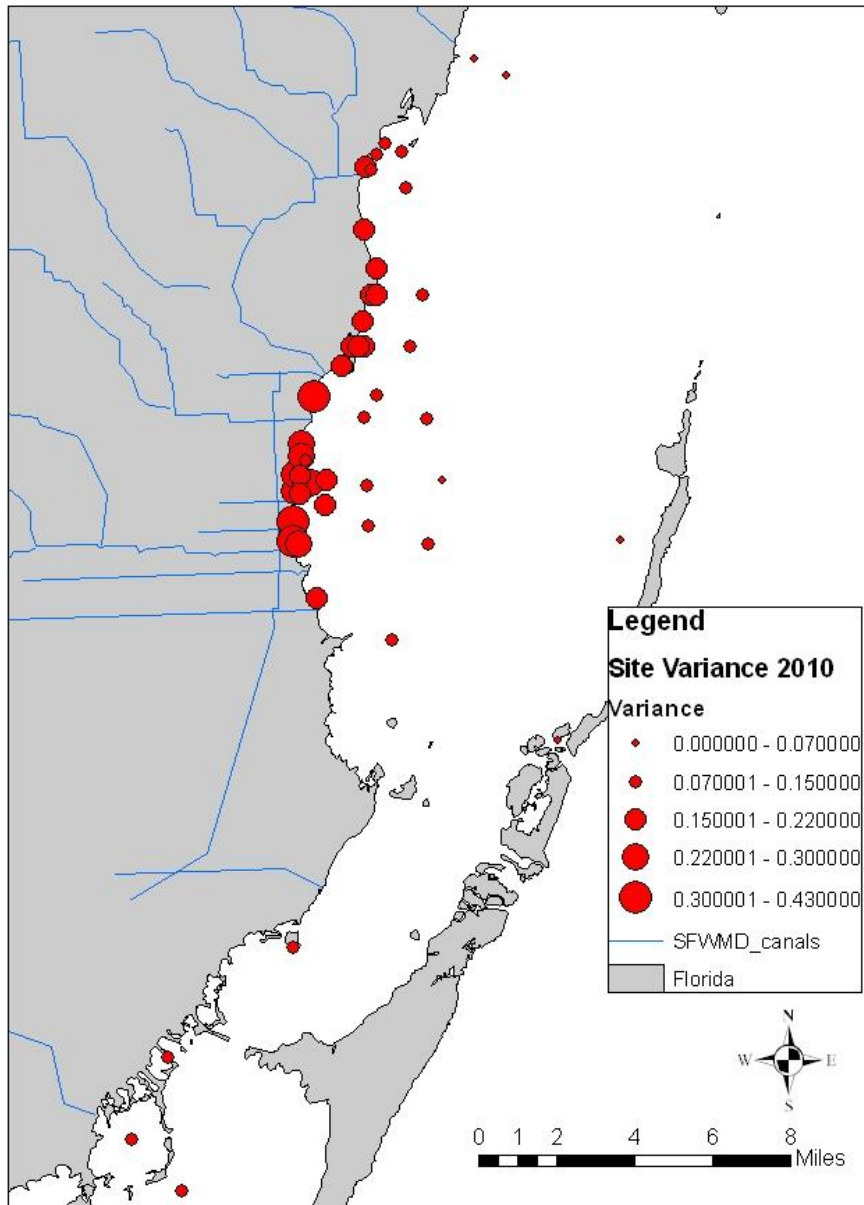


Figure 3.3-1: Variance proportional to dot size mapped for the year 2010.

4.0 CERP Performance Measure: Biscayne Bay and Manatee Bay

4.1.1 Biscayne Bay Performance measure

The CERP Biscayne Bay Coastal Wetlands (BBCW) project and the RECOVER Southeast Estuaries teams have developed performance measures for Biscayne Bay. These performance measurements include re-establishing a persistent estuarine zone, of varying salinity depending on season and fresh water input, along the western shoreline of portions of Central and Southern Biscayne Bay. In the area between Turkey Point and Shoal Point the restoration goal is to establish a zone of mesohaline (5-18 psu) conditions with lower salinity in connecting tidal creeks. These targets were then defined for the area from the shoreline eastward to between 250 m and 500 m offshore. Both wet and dry season targets were established in the area between Turkey Point and Shoal Point, where the wet season (June 1 through October 31) has an average target salinity of 20 psu in an area extending 500 m from shore, and the dry season (November 1 through May 31) target has an average salinity of 20 psu in an area extending 250 m from shore (**Figure 4.1-1**).

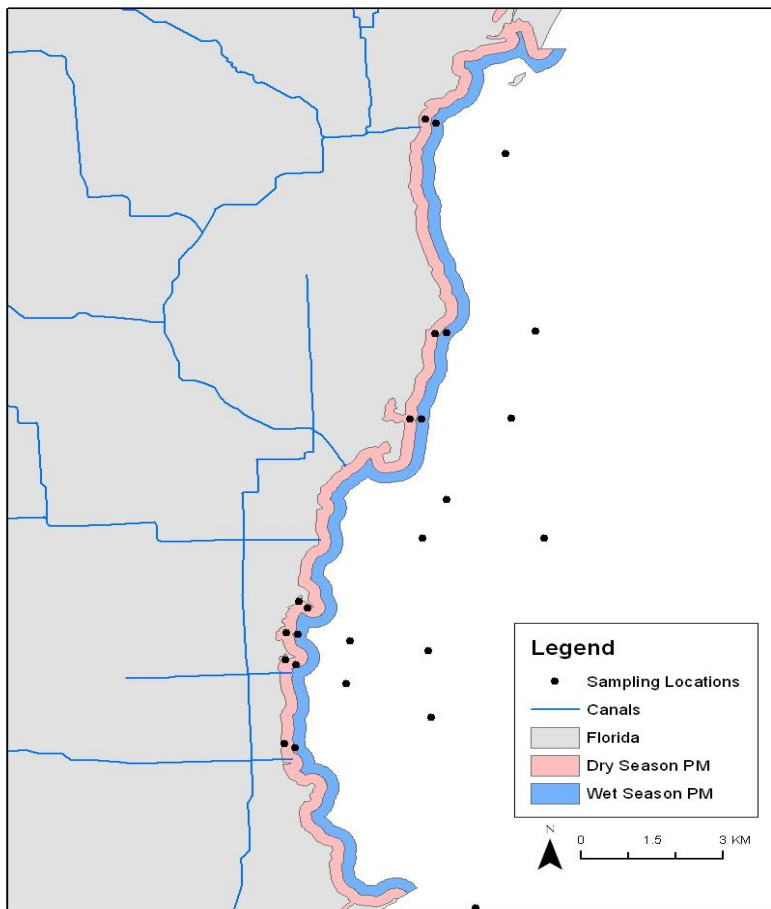


Figure 4.1-1: Dry and wet season performance measures (PM). The performance measure for Biscayne Bay during the dry season is to have an estuarine zone stretching from the shoreline to 250 m offshore, and 500 m during the wet season.

An estimated average daily canal flow rate of 1,051 (cfs) is required to meet the wet season target and an average estimated daily canal flow rate of 346 cfs is required to meet the dry season target (Meeder *et al.* 2001). Although an estuarine zone has been produced in Biscayne Bay every wet season since this project began, the size, shape and extent of this zone vary depending on the Central & Southern Florida Project (C&SF Project) system canal operations, local flow, meteorological, and hydrographic conditions. **Appendix V** contains figures illustrating estuarine zones based on measured salinities for water years 2004-2005; 2005-2006; 2006-2007, 2007-2008 and 2008-2009. Months containing an estuarine zone (0-20 psu) for water year 2009-2010 are shown in **Figures 4.1-2 to 4.1-9**. Months displaying no estuarine zone (above 20 psu) based on measured salinity criteria are not shown.

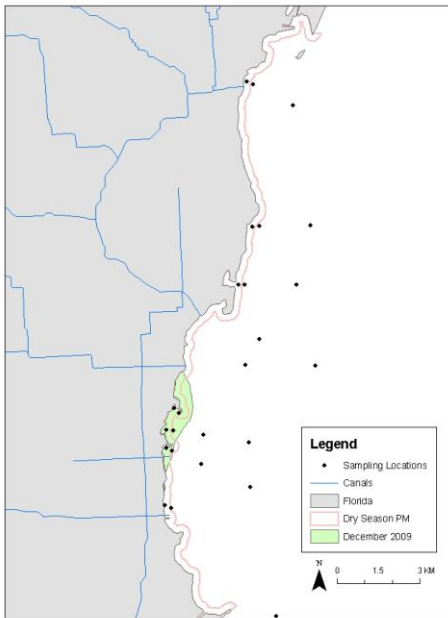


Figure 4.1- 2: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in December 2009.

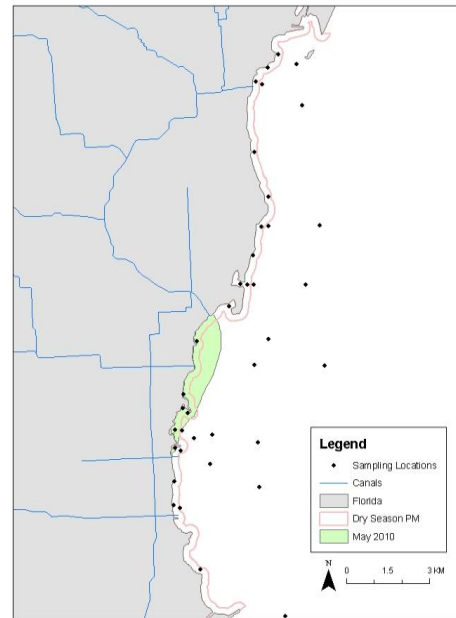


Figure 4.1- 4: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in May 2010.

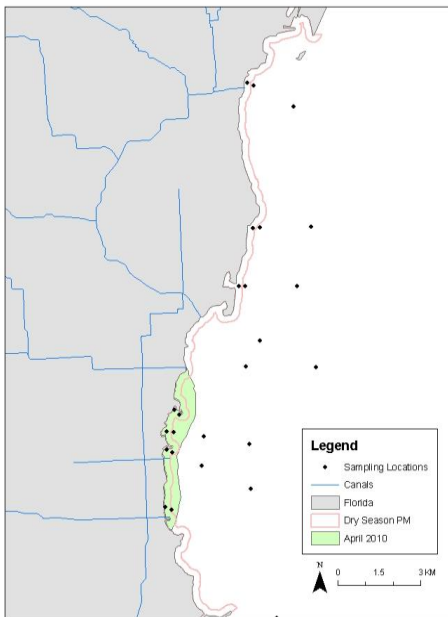


Figure 4.1- 3: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in April 2010.

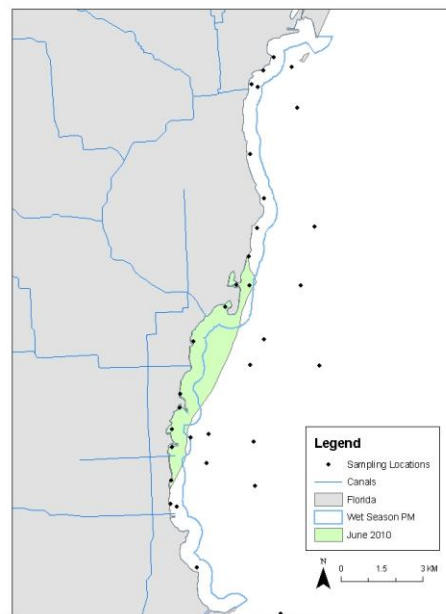


Figure 4.1- 5: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in June 2010.

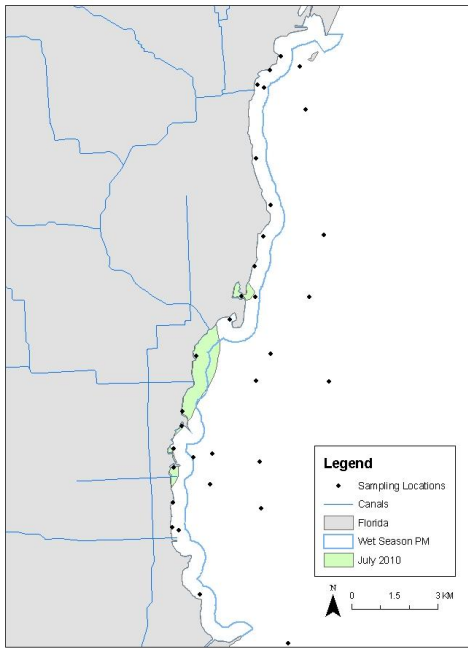


Figure 4.1- 6: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in July 2010.

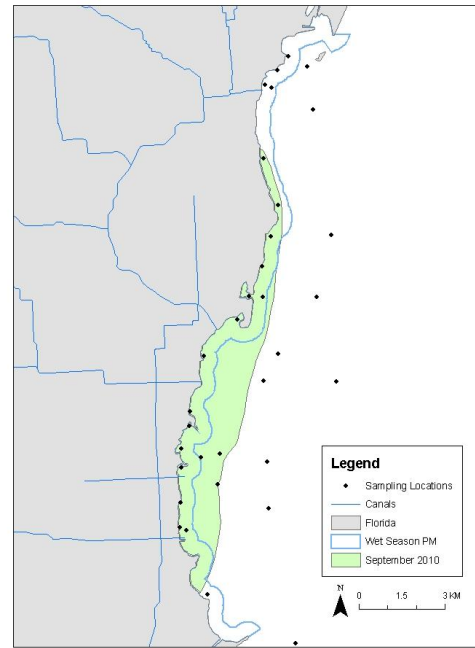


Figure 4.1- 8: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in September 2010.

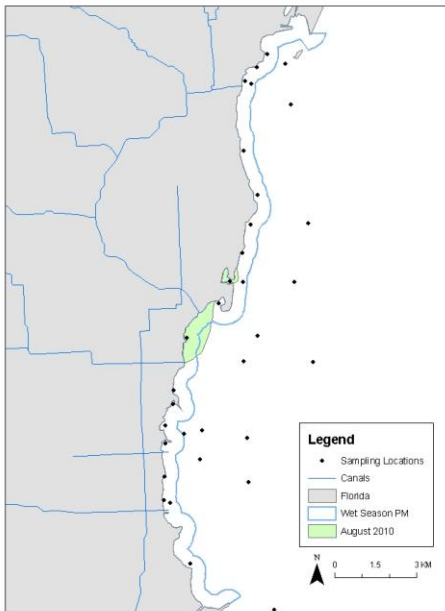


Figure 4.1- 7: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in August 2010.

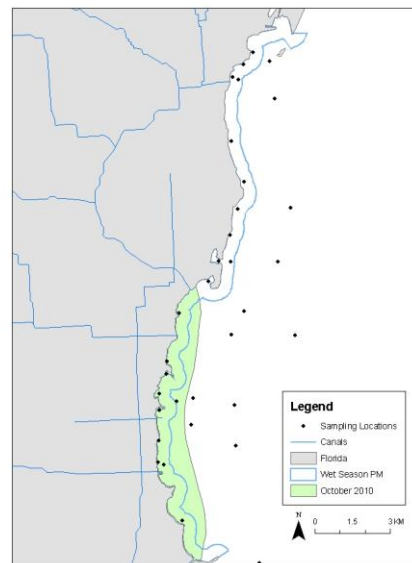


Figure 4.1- 9: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in October 2010.

Examination of freshwater inflow data from canals discharging into Biscayne Bay, and the resulting estuarine areas are presented in **Table 4.1-2**. There were fluctuations in monthly average annual salinity over the water year 2009-2010.. Between August 2010 and September 2010, average monthly salinity levels decreased by 7 psu (**Table 3.2-1**). Canal discharge, based on the sum of measured flows at the coastal outfalls S20F, S20G, S21A, S21, and S123, increased during this same time period from 292.86 to 324.05 Kaf (**Table 4.1-2**). During the end of the wet season, the South Florida Water Management District (SFWMD) typically lowers the groundwater stage through large freshwater releases. As a result, September had the lowest salinity for this period and formed the largest estuarine zones covering 4,261 acres (**Table 4.1-1**). There was a larger estuarine zone area in 2010 than in 2009 with lower monthly average salinity (**Table 4.1-2**) (**Figures 4.1-2 and 4.1-5**). Eight months had an estuarine area in 2010 and three in 2009. The year 2010 had bigger canal discharge than 2009. For example, the April 2009 canal discharge increased from 0.76 to 31.89 Kaf in April 2010 (**Table 4.1-2**). This is the first year when estuarine zones developed in April and May (**Table 4.1-1**). There were estuarine zones every month between April 2010 and November 2010. This is likely due to a combination of a dry period and altered operations for the C & SF Project canals in South Miami-Dade County.

Table 4.1-1: Estuarine areas (in acres) by month for the period of record (2004-2010). This information has been derived from interpolations using ArcGIS.

Year	Est. Area of Salinity <20 psu (acres)	Difference Area of <20 psu and Performance Target	Average Monthly Canal Discharge in cfs (summed S20F, S20G, S21A, S21, S123)
2004			
September +	204	-3,568	49,797
October +	2,738	-1,034	38,430
November *	1,841	-176	23,384
December *	247	-1,770	12,890
2005			
June +	4,186	414	69,377
July +	3,406	-366	56,035
August +	3,214	-558	68,693
September +	3,335	-437	112,144
October +	5,368	1,596	122,143
November *	1,481	-536	67,092
December *	110	-1,907	18,548
2006			
January *	91	-1,926	7,602
July +	2,255	-1,517	49,122
August +	1,960	-1,812	37,520
September +	2,036	-1,736	45,970
October +	1,013	-1,004	32,105
November *	53	-1,964	14,190
December *	811	-1,206	9,427
2007			
January*	298	-1,719	5,417
June +	34	-3,738	37,273
July +	3,684	-88	26,878
October +	5,646	1,874	42,544
November *	1,968	-49	22,117
December *	442	-1,575	3,491
2008			
August +	78	-3,694	46,613
September +	1,123	-2,649	26,040
October +	5,866	2,094	51,161
November *	1,183	-834	19,134
December *	728	-1,289	6,965
2009			
July +	1,021	-2,751	28,582
September +	554	-3,218	30,496
December *	445	-1,572	18,065
2010			
April *	840	-1,177	16,083
May *	801	-1,216	13,120
June +	1,764	-2,008	20,013
July +	642	-3,130	13,321
August +	405	-3,367	24,911
September +	4,261	489	42,885
October +	2,860	-912	25,909
November *	1,825	-192	14,603
* Dry Season	Dry Season Performance Measure (acres)	2,017	
+ Wet Season	Wet Season Performance Measure (acres)	3,772	

Table 4.1-2: Estimated Average Monthly Canal Discharge in thousand acre feet (Kaf) (summed for S20F, S20G, S21A, S21, and S123)

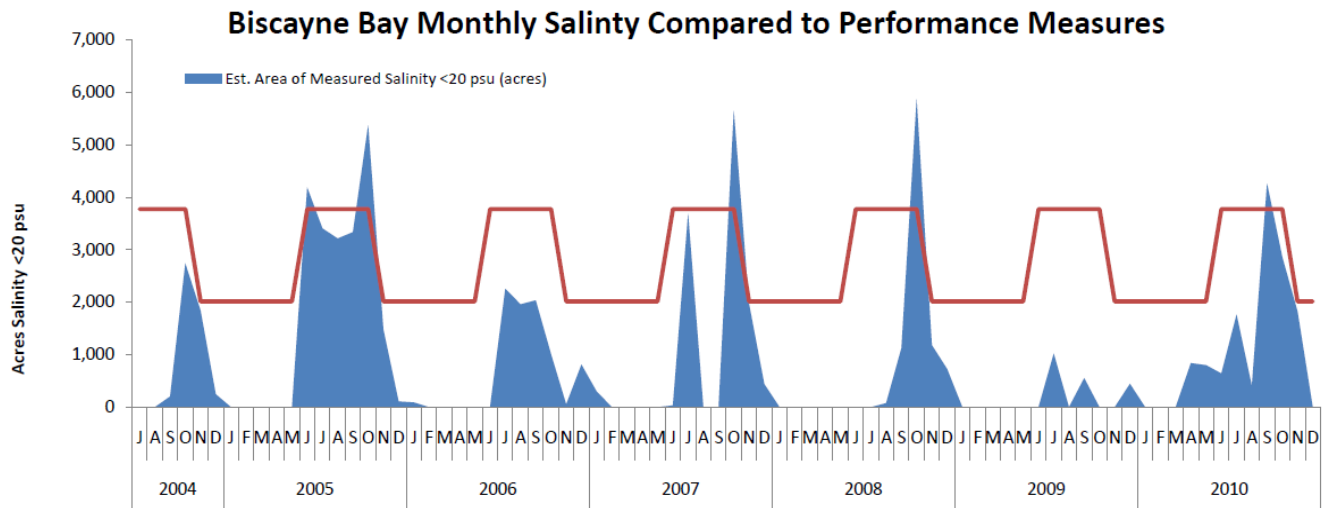
	Monthly Discharge (Kaf)						
	2004	2005	2006	2007	2008	2009	2010
January	6.46	7.8	12.17	10.54	4.64	4.89	44.33
February	13.5	3.68	15.16	10.23	5.75	1.41	25.66
March	2.25	7.78	9.21	1.9	5.71	6.92	20.68
April	0.69	2.64	7.1	9.49	17.26	0.76	31.89
May	0.91	3.39	7.06	9.99	1.94	18.16	26.02
June	0	121.21	7.29	74.96	31.36	69.41	39.69
July	7.35	66.72	73.48	52.31	44.37	56.68	26.42
August	66.07	103.68	45.39	16.29	92.43	35.07	49.40
September	71.68	105.48	64.36	42.1	51.64	60.47	85.04
October	77.56	70.55	34.84	82.8	101.45	34.01	51.38
November	47.28	25.36	28.54	44.48	37.94	35.18	28.96
December	27.86	22.72	18.35	6.79	13.81	35.82	12.02
Annual Total	321.61	541.01	322.95	361.88	408.3	358.78	441.48

Water volume and salinity records cited in Gaiser *et al.* (2004; 2006) and SFNRC, 2006, reveal that the existing CERP estimate for restoration salinity appears to be much less than the amount of water that historically flowed into Southern Biscayne Bay through groundwater and surface water. Monthly annual canal flow (in thousand acre feet or Kaf) through structures S20F, S20G, S21A, S21, and S123 are shown in **Table 4.1-2**. The estuarine zone is generally not uniformly distributed along the western shoreline as shown in the **Figures 4.1-2 to 4.1-9 and in Appendix V, Estuarine Zones**. Figures found in **Appendix V** display the estuarine zones area of coverage for the current period of record (2004-2009). If a month is not included in **Table 4.1-1** or in **Appendix V**, it is because no estuarine zone stabilized during that particular month. As previously stated, the performance measure dictates a 500 m wide estuarine zone from Turkey Point to Shoal Point during the wet season and a 250 m wide zone during the dry season. These performance measures are based on the intention to spread freshwater flow out across a broad front, so it may flow through the mangroves rather than through the canal system (current Pre-CERP conditions)

Under the current Pre-CERP existing flow patterns, the estuarine zone does not extend completely north to Shoal Point or south to Turkey Point, rather it extends out further from the shoreline between C-103 and Black Point, most likely due to the evidence of the effects of canal discharge (**Figures 4.1-2 to 4.1-5**). **Figure 4.1-6a** shows graphically the salinity response relative to the performance measures for wet season and dry season for Biscayne Bay. The flow (in cfs) is shown in Figure 4.-6b a reference for all years sampled. Given this salinity response, it is likely that both discharge and groundwater are required to maintain low salinity zones. By using these figures and comparing monthly canal discharge patterns (Figure 4.-6b) to salinity patterns in the Bay and monthly plots of the salinity zone for the period of record (Figure 4.-6a), a larger role for

groundwater in maintaining this area than has previously been considered is apparent (**Appendix V, Estuarine Zones**).

A.



B.

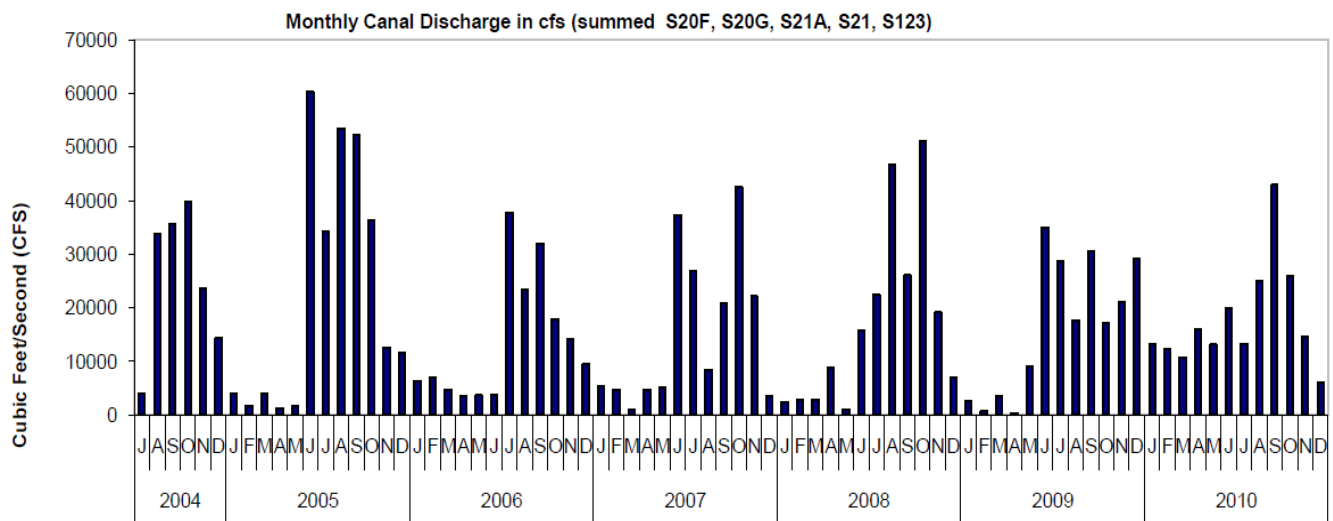


Figure 4.1-10: a) Estimated actual area of salinity below 20 psu vs. CERP performance measure estuarine area in acres. b) Canal Discharge in CFS to show the relationship between discharge and salinity response.

4.1.2 Manatee Bay performance measure

The current RECOVER Biscayne Bay CERP performance measures for Manatee Bay and Barnes Sound are as follows:

Manatee Bay and Barnes Sound Performance Measure:

Wet Season:

The wet season (June-October) salinity restoration target specifies maintaining an average salinity between 5 and 15 psu in coastal embayments and Manatee Bay, between 15 and 30 psu at the mouths of coastal embayments and Barnes Sound, and between 15 and 30 psu within Barnes Sound for 90 % of the wet season (**Table 4.1-3 and Figures 4.1-7, 4.1-8 and 4.1-9**).

Dry Season:

During the dry season (November-May) the salinity restoration target calls for an average salinity ranging between 10 and 19 psu in coastal embayments and Manatee Bay, between 20 and 32 psu at the mouths of coastal embayments and Barnes Sound, and between 20 and 35 psu within Barnes Sound 90 % of the time. Daily average salinity is expected to remain at <35 psu at all locations for 95 % of the dry season (**Table 4.1-3 and Figure 4.1-7, 4.1-8 and 4.1-9**).

The restoration goals for the water year 2009-2010 have not been met for Manatee Bay and are only met for Barnes Sound in the wet season, October, and in the dry season, November, December, and January. Manatee Bay and Barnes Sound average salinities are consistently higher than the stated restoration targets for this water year and for all years sampled. Additionally, extreme high salinities are often recorded during both wet and dry seasons. Due to the lack of low salinity values the variance of this data is lower than that of comparable sites to the north of Convoy Point. In comparing the Manatee Bay-Barnes Sounds data to the rest of the data set for Biscayne Bay these sounds have consistently high salinity, never reach zero, and average salinity that approaches sea water.

Table 4.1-3: Statistical summary of BISC Salinity Monitoring Program (psu) (2004-2010) for Manatee Bay and Barnes Sound.

Site	Count	Average (psu)	Minimum (psu)	Median (psu)	Maximum (psu)	Range (psu)	st dev	Coef. of Variation
Manatee Bay	217130	30.01	9.44	29.23	48.44	39.00	5.74	0.19
Barnes Sound	211978	31.83	17.98	31.91	41.79	23.81	4.75	0.15

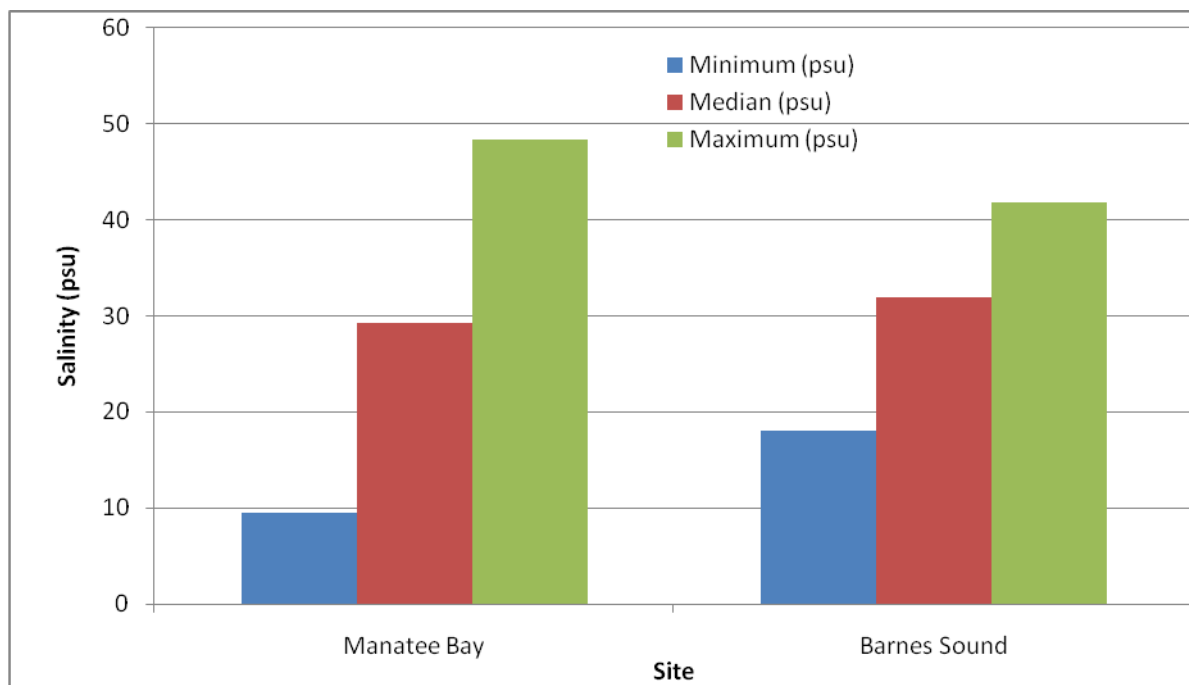


Figure 4.1.2-1: Salinity Minimum, Maximum, and Median in (psu) for Manatee Bay & Barnes Sound (2004-2010) showing that the area does not meet salinity PM for this area.

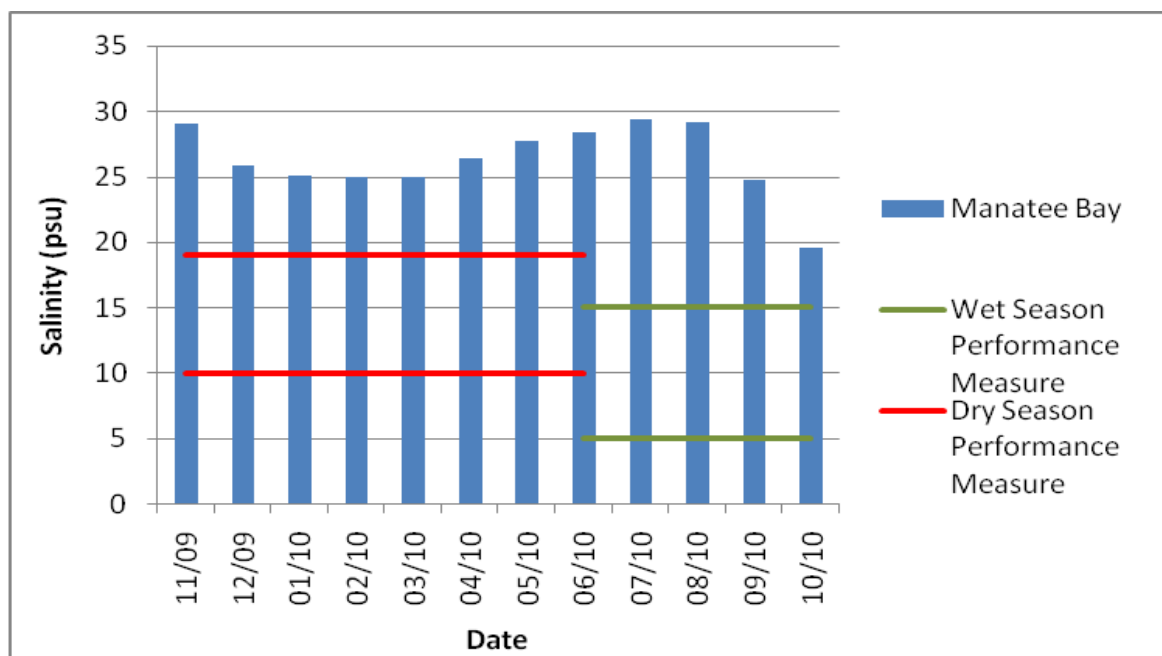


Figure 4.1.2-2: Manatee Bay Performance Measure (November 2009 – October 2010).

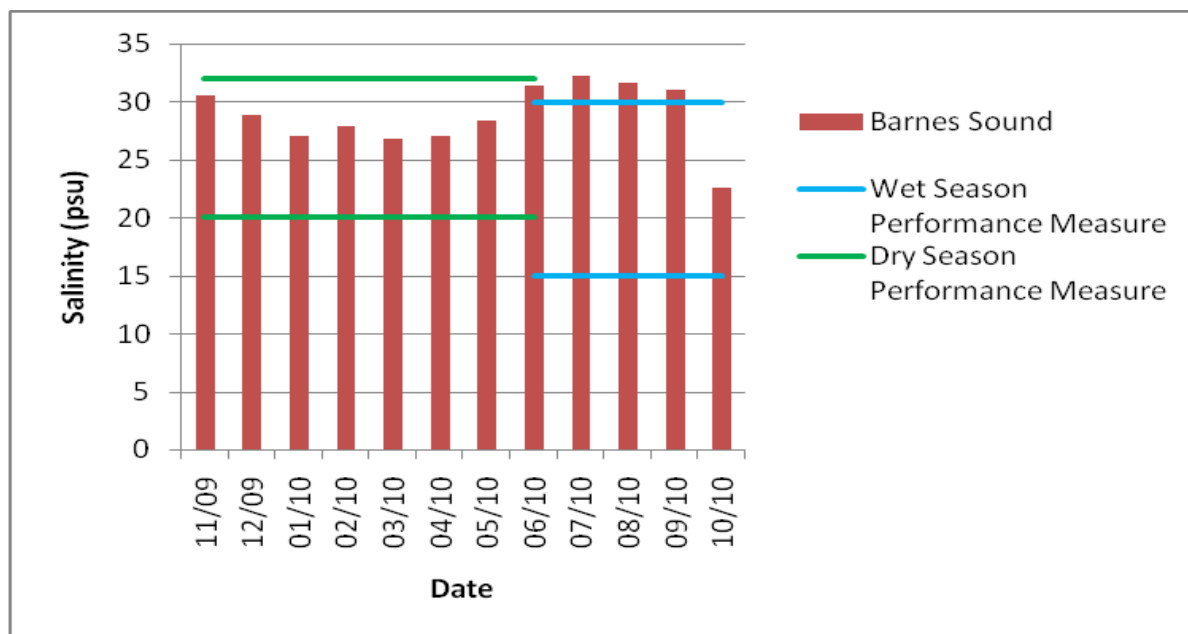


Figure 4.1.2-3: Barnes Sound Performance Measure (November 2009 – October 2010).

5.0 Summary and Conclusion

During water year 2009-2010 several unusual occurrences happened. A large area of high salinity water developed and was sustained in central Biscayne Bay during the wet season. The sites in this area are deep 6-7 ft (~2m) so this was a water column event. This year there was also the early development of low salinity water creating an estuarine zone along the western shoreline beginning in April and the resultant long persistence of an estuarine zone along the shoreline. This occurs in the area of the persistence of high salinity. Reviewing the estuarine graphics there appears to be a relationship between antecedent conditions of canal flow and the longer persistence of an estuarine zone. Movement of the sites does not appear to alter the data. Future work will review the statistical relationships between the estuarine zone, its persistence and flow.

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Appendix I

Biscayne Bay Nearshore Salinity Monitoring Network Optimization

Biscayne Bay Nearshore Salinity Monitoring Network Optimization

The intended purpose of the Monitoring and Assessment Plan (MAP) is to document restoration-induced change and to provide data amenable to adaptively managing the operation of constructed features. The original salinity monitoring network in Biscayne Bay was configured to provide a better understanding of general salinity patterns within Biscayne National Park. This configuration was supplemented in 2005 with additional stations to better monitor nearshore areas of Biscayne Bay considered to be important sentinel sites for monitoring changes in salinity due to Comprehensive Everglades Restoration Plan (CERP) projects implementation. At the time, salinity measurements in the shallow nearshore zone were especially needed because; (1) no data is existed for this region, (2) this area exhibited high salinity dynamics, (3) this region was the focus of multiple performance measures, and (4) had the greatest potential of being affected by CERP. After reviewing the last 5 years of data collected by the network, it has been determined by the Southern Coastal Systems Assessment Team Module that an optimization of the existing network is warranted. The new sampling design aims to provide data to better assess downstream effects of the Biscayne Bay Coastal Wetlands (BBCW) Project on nearshore salinity regimes, supplement ongoing MAP biological monitoring in Biscayne Bay, and to provide continuous salinity data to Biscayne Bay modeling efforts.

Synopsis:

All surface sites except 01 and 05 will be discontinued. It has been deemed that 5 years of surface data are sufficient for model calibration purposes, documenting the occurrence and extent of stratification, and determining bottom/surface salinity relationships. The surface instruments are moved to newly created sites to fill spatial data gaps in the network and to capture salinity conditions at select sites. See Figures 1 and 2 for maps showing the current and proposed optimized network. See Table 1 for latitude/longitude positioning of sites and status/justification for discontinuing sites and establishment of new sites. Figure 3 shows the five sites in northern Biscayne Bay operated by Miami-Dade DERM as part of a cooperative agreement with BNP.

The optimized network will consist of 48 monitoring locations (48 bottom, 2 surface). This is no net gain of instruments from the existing network.

Figure 1. The current (existing) network.

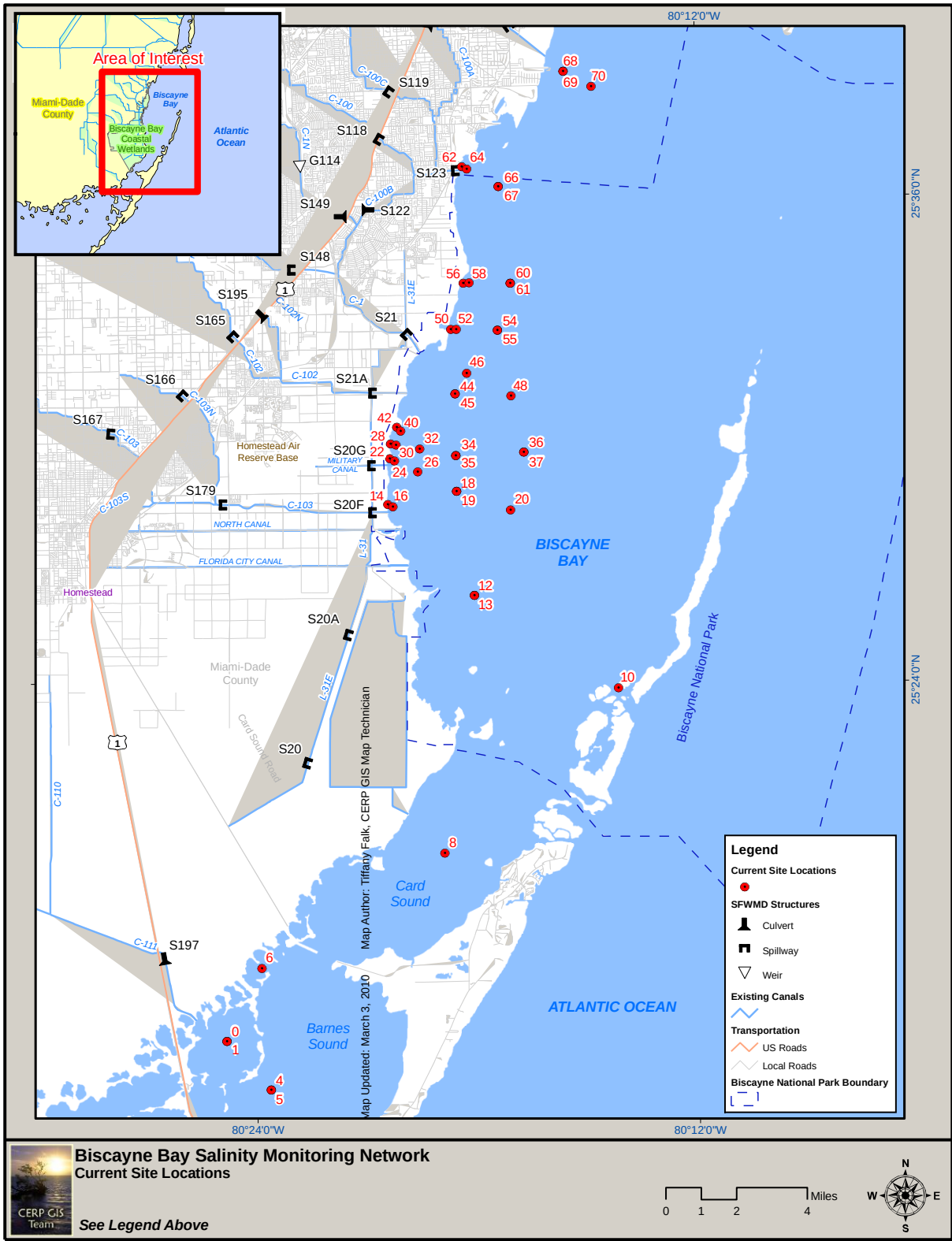


Figure 2. New proposed “optimized” network in South Biscayne Bay.

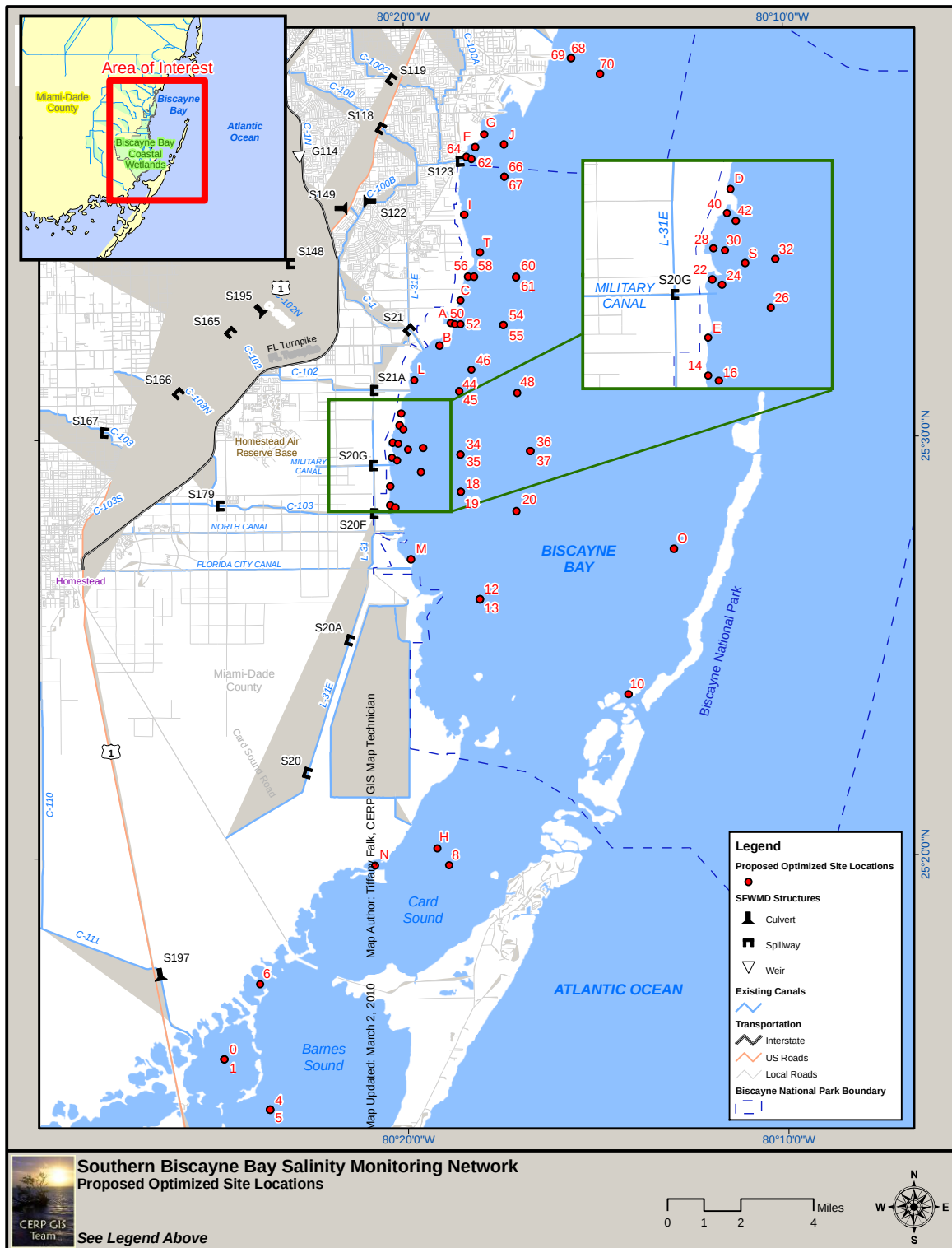


Table 1. Location and status of existing salinity monitoring sites for the Biscayne Bay network.

Site Name	LATITUDE	LONGITUDE	STATUS
00	25.25300	-80.41400	Unchanged
01	25.25300	-80.41400	Unchanged
04	25.23300	-80.39400	Unchanged
05	25.23300	-80.39400	Unchanged
06	25.28300	-80.39800	Unchanged
08	25.33000	-80.31500	Site had logistics/location problems. Sonde was continually buried by sediment making retrieval difficult; moved to co-locate with a surface structure and renamed Site H
10	25.39769	-80.23597	Data from Caesar Creek determined to be representative of open ocean conditions and existing data set is sufficient for model calibration; discontinued
12	25.43600	-80.30100	Unchanged
13	25.43600	-80.30100	Discontinued surface location
14	25.47360	-80.34004	Unchanged
16	25.47264	-80.33777	Unchanged; site suggests an alongshore salinity gradient when compared to Site 14, see Table 3
18	25.47878	-80.30886	Unchanged
19	25.47878	-80.30886	Discontinued surface location
20	25.47103	-80.28453	Unchanged
22	25.49242	-80.33911	Unchanged
24	25.49133	-80.33694	Deemed redundant to Site 22 (similar data patterns), see Table 3; discontinued
26	25.48681	-80.32650	Unchanged
28	25.49844	-80.33875	Unchanged
30	25.49800	-80.33627	Deemed redundant to Site 28 (similar data patterns), see Table 3; discontinued
32	25.49633	-80.32548	Unchanged
34	25.49353	-80.30908	Unchanged
35	25.49353	-80.30908	Discontinued surface location
36	25.49472	-80.27836	Unchanged
37	25.49472	-80.27836	Discontinued surface location
40	25.50531	-80.33577	Unchanged
42	25.50375	-80.33400	Logistical problems with sonde sinking into the sediment and deemed redundant to Site 40 (similar data patterns), see Table 3
44	25.51886	-80.30940	Moved NW, closer to shore to capture along shore salinity gradient
45	25.51886	-80.30940	Discontinued surface location
46	25.52728	-80.30406	Unchanged
48	25.51800	-80.28400	Unchanged
50	25.54547	-80.31119	Deemed redundant to Site 52 (similar data patterns), see Table 3; discontinued
52	25.54539	-80.30869	Unchanged
54	25.54500	-80.29000	Unchanged
55	25.54500	-80.29000	Discontinued surface location
56	25.56444	-80.30531	Unchanged

Table 1 (cont.)

Site Name	LATITUDE	LONGITUDE	STATUS
58	25.56447	-80.30278	Deemed redundant to Site 56 (similar data patterns), see Table 3 discontinued
60	25.56428	-80.28417	Unchanged
61	25.56428	-80.28417	Discontinued surface location
62	25.61225	-80.30583	Unchanged
64	25.61136	-80.30353	Unchanged
66	25.60408	-80.28922	Unchanged
67	25.60408	-80.28922	Discontinued surface location
68	25.65128	-80.25958	Unchanged
69	25.65128	-80.25958	Discontinued surface location
70	25.64500	-80.24700	Unchanged
76	25.75628	-80.17426	Unchanged (site also known as BB22-B)
80	25.77108	-80.18160	Unchanged (site also known as PORTW-B)
82	25.83008	-80.15857	Unchanged (site also known as BB14-B)
84	25.92947	-80.15037	Unchanged (site also known as SK01)
88	25.94487	-80.12777	Unchanged (site also known as BB01-B)

Table 2. Location of new salinity monitoring sites for the Biscayne Bay network.

Site Name	LATITUDE	LONGITUDE	STATUS	Original Site
A	25.54600	-80.31300	New site fills spatial gap	50
B	25.53700	-80.31800	New site fills spatial gap	61
C	25.55500	-80.30870	New site fills spatial gap	58
D	25.51000	-80.33500	New site fills spatial gap	37
E	25.48100	-80.34000	New site fills spatial gap	45
F	25.61600	-80.30200	New site fills spatial gap and positioned to capture conditions at Deering's south creek	30
G	25.62100	-80.29800	New site fills spatial gap and positioned to capture conditions at Deering's north creek	24
H	25.33679	-80.32008	Relocation of Site 08; moved to co-locate with a surface structure	08
I	25.58903	-80.30696	New site fills spatial gap	69
J	25.6171	-80.28916	New site fills spatial gap	42
L	25.52330	-80.32911	New site fills spatial gap; Site moved from initial location at C-102 canal mouth to better location slightly to the north.	35
M	25.45200	-80.33100	New site fills spatial gap	67
N	25.33003	-80.34733	New site fills spatial gap	19
O	25.45571	-80.21570	New site fills spatial gap	10
S	25.49559	-80.33197	New site fills spatial	55
T	25.57415	-80.30010	New site fills spatial gap	13

Table 3. Summary statistics for discontinued paired sites (salinity in psu)

Site	n	Avg	Min	Median	Max	Range	SD	CV
22	151734	21.91	1.11	21.87	43.51	42.4	7.9	0.36
24	154627	23.35	0.51	23.25	44.67	44.17	7.86	0.34
28	161370	22.14	0.01	22.08	44.5	44.5	8.1	0.37
30	155131	22.66	0.61	22.49	44.94	44.33	7.9	0.35
40	162723	21.44	0	20.97	45.56	45.56	8.4	0.39
42	152649	21.45	1.19	21.03	46.22	45.03	8.17	0.38
50	146900	24.53	1.15	24.19	45.54	44.39	7.79	0.32
52	154224	24.78	0.34	24.17	45.09	44.75	7.18	0.29
56	164411	26.11	1.31	26.63	46.59	45.28	7.6	0.29
58	155389	26.24	0.48	26.42	45.28	44.8	7.33	0.28

Figure 3. Northern Biscayne Bay sites as part of cooperative arrangement with DERM.

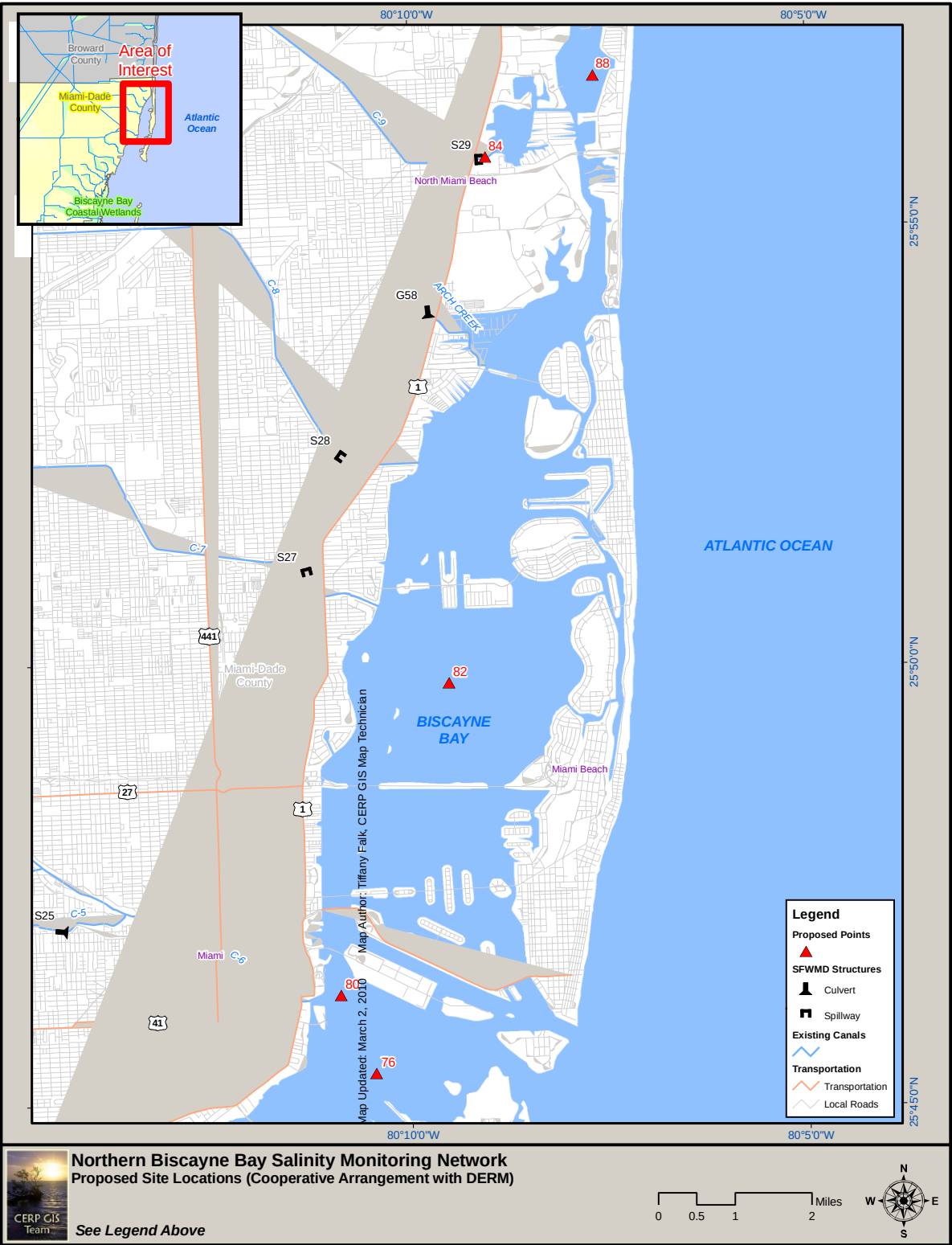
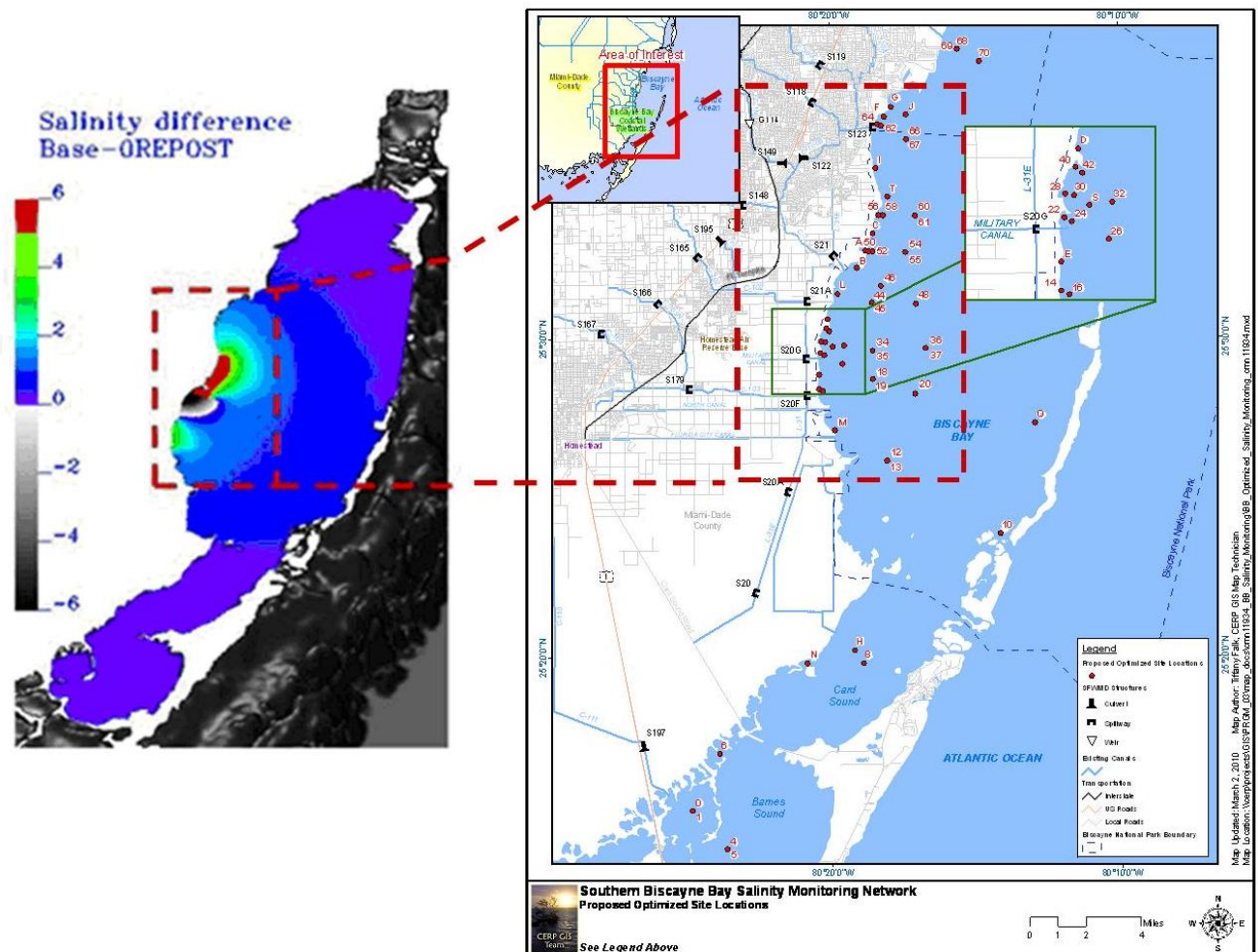


Figure 4. Graphic depicting focus of revised network on areas of expected change.



Appendix II – QA/QC Plan

QA/QC Plan

Biscayne Bay Salinity Monitoring Network Data Collection, Verification, and Validation (2011) Quality Assurance and Quality Control Plan

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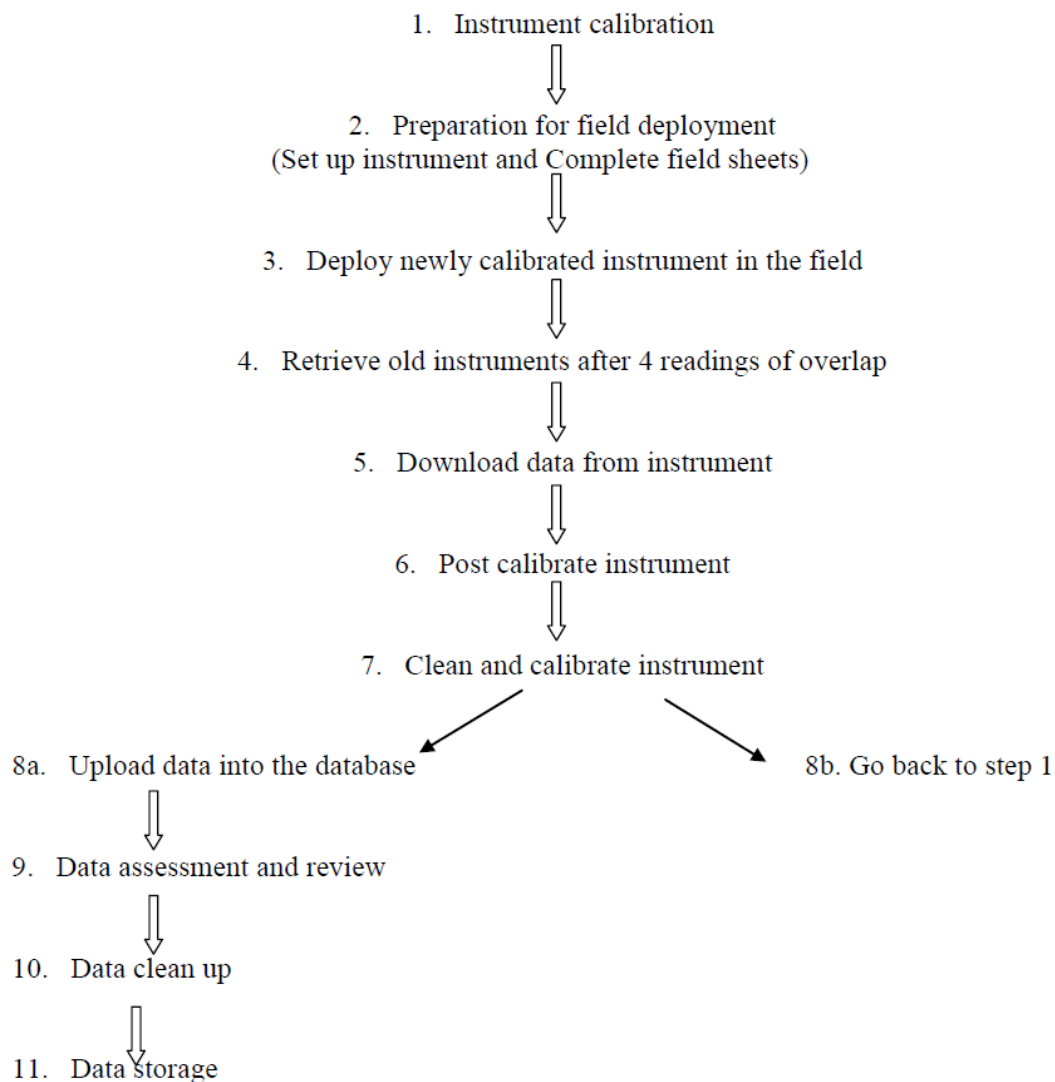
7.0 References

Appendix A	Sonde Set-Up
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1.0 Introduction

This is a Quality Assurance/Quality Control (QA/QC) plan for all field data collection, laboratory procedures, data validation and verification for the REstoration COordination and VERification (RECOVER)/Biscayne Bay Salinity Monitoring Network. This plan is also intended to meet the requirements of quality control and assurance of field-testing as outlined by the South Florida Water Management District (SFWMD).

The following plan describes the objectives, functional activities, and specific quality assurance and control procedures for the collection of physical data in Biscayne Bay to support the Monitoring and Assessment Program (MAP) for the Comprehensive Everglades Restoration Plan (CERP). Documents used in preparing this QA/QC plan are listed on the reference page of this document. Below is a flow chart of general standard operating procedures.



2.0 Statement of Project Purpose and Approach

2.1 Purpose

The purpose of the Biscayne Bay Salinity Monitoring Network (BBSMN) program is to provide water quality data results including temperature, water level, conductivity and salinity during a limited but continuous long-term monitoring survey. This project's goals are: 1) to collect physical water quality data (primarily conductivity and calculated salinity) to allow decisions and inferences to be made with respect to changes in freshwater inflow, 2) to distribute this data in the broadest manner, and 3) to provide this information in a manner most useful to researchers.

2.2 Approach

2.2.1 Location

Data collection and analysis is conducted with adherence to accepted scientific and engineering principles to provide technically correct and scientifically defensible results. There are 47 sites where data is collected within Biscayne Bay (**Figure 2.2.1** and **Table 2.2.1**). The northernmost site is located offshore and south of the Snapper Creek Canal. Sites continue south through the bay to Card Sound, Barnes Sound and Manatee Bay. The sampling sites are set up as a series of east-west transects that radiate outward from canals or other important hydrological features and are located along the shoreline to pick up the most likely changes due to CERP related water flow alterations. These transects are meant to document a progression of estuarine conditions from nearshore to marine conditions offshore as well as related fluctuations.

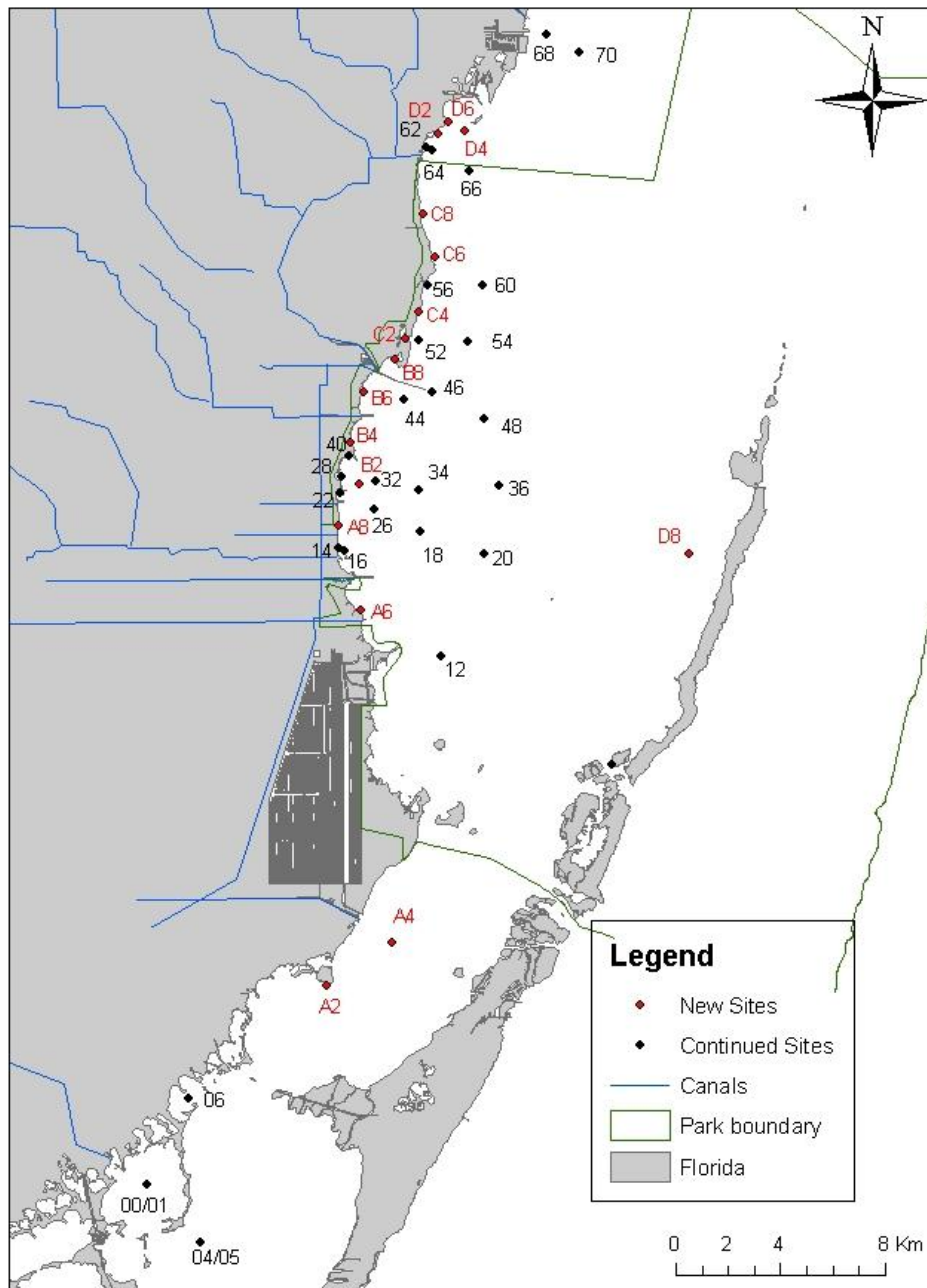


Figure 2.2.1: Map showing all the sites in the project

Table 2.2.1: Listing of all sites with GPS coordinates and location relative to the water column

Site ID's	Latitude	Longitude	Instrument Type	Deployment
00	25.253	-80.414	Bottom	Horizontal
01	25.253	-80.414	Surface	Vertical
04	25.233	-80.394	Bottom	Horizontal
05	25.233	-80.394	Surface	Vertical
06	25.283	-80.398	Bottom	Horizontal
10	25.39769	-80.23597	Bottom	Vertical
12	25.436	-80.301	Bottom	Horizontal
13	25.436	-80.301	Surface	Vertical
14	25.47361	-80.34003	Bottom	Horizontal
16	25.47264	-80.33777	Bottom	Horizontal
18	25.47878	-80.30886	Bottom	Horizontal
20	25.47103	-80.28453	Bottom	Vertical
22	25.49242	-80.33911	Bottom	Horizontal
26	25.48681	-80.3265	Bottom	Horizontal
28	25.49844	-80.33875	Bottom	Horizontal
32	25.49633	-80.32548	Bottom	Horizontal
34	25.49353	-80.30908	Bottom	Horizontal
36	25.49472	-80.27836	Bottom	Horizontal
40	25.50533	-80.33577	Bottom	Horizontal
44	25.52473	-80.31457	Bottom	Horizontal
46	25.52728	-80.30406	Bottom	Vertical
48	25.518	-80.284	Bottom	Horizontal
52	25.54539	-80.30869	Bottom	Horizontal
54	25.545	-80.29	Bottom	Horizontal
56	25.56444	-80.30531	Bottom	Horizontal
60	25.56428	-80.28417	Bottom	Horizontal
62	25.61225	-80.30583	Bottom	Horizontal
64	25.61136	-80.30353	Bottom	Horizontal
66	25.60408	-80.28922	Bottom	Horizontal
68	25.65128	-80.25958	Bottom	Horizontal
70	25.645	-80.247	Bottom	Horizontal
A2	25.32186	-80.3454	Bottom	Horizontal
A4	25.33679	-80.32008	Bottom	Horizontal
A6	25.45211	-80.3313	Bottom	Horizontal
A8	25.48128	-80.3397	Bottom	Horizontal
B2	25.49547	-80.332	Bottom	Horizontal
B4	25.51011	-80.3353	Bottom	Horizontal
B6	25.52728	-80.3299	Bottom	Horizontal
B8	25.53853	-80.3178	Bottom	Horizontal
C2	25.54586	-80.3137	Bottom	Horizontal
C4	25.55506	-80.3088	Bottom	Horizontal
C6	25.57425	-80.3026	Bottom	Horizontal
C8	25.58897	-80.307	Bottom	Horizontal
D2	25.61678	-80.3013	Bottom	Horizontal
D4	25.61767	-80.2908	Bottom	Horizontal
D6	25.62097	-80.2974	Bottom	Horizontal
D8	25.47061	-80.206	Bottom	Horizontal

2.2.2 Deployment

Instruments are primarily deployed horizontally on a concrete paver on the bay bottom fitted with two eyebolts (**Figure 2.2.2.1**). Three bottom instruments are deployed vertically. Both benthic deployment types allow instruments to collect data at the same depth above the bottom (**Figure 2.2.2.2c & b**). Three of the 47 sites within the bay also acquire readings approximately 0.25 meters below water surface via instruments placed within a U. S. Coast Guard permitted surface buoy (**Figure 2.2.2.2a**). This configuration allows for the simultaneous deployment of two instruments taking overlapping readings. These overlapping readings are then used in QA/QC analysis of the data. The buoys used in this deployment type are specifically designed for this application and are made by modifying a normal can buoy incorporating two tubes of PVC pipe approximately four inches in diameter running the height of the buoy. The tops of these PVC pipes are fitted with PVC caps which are drilled and set with eyebolts from which small link stainless steel chain is hung. From the chain, using a snap shackle for ease, the 6600 meters are attached and hung at a consistent depth of approximately 0.25 meters below water surface.

. Instrument deployment is set up to allow the simultaneous reading by two instruments. This data is then used in the QA/QC process. At those sites with horizontal deployment, the instrument is locked onto a concrete paver fitted with two eyebolts. At one end, the smaller eyebolt has two UV-black cable ties as a guide and a means to hold the instruments together at consistent depth. The both instruments are inserted through one large black UV resistant cable tie on each side of the eyebolt to hold the meters in the correct position (Figure 2.2.2.2 b). The other eye bolt at the far end of the paver is used to lock the instrument down with a brass padlock. Only the instrument that will remain on the bottom for the subsequent deployment will be locked. During horizontal deployment, it is essential the sensor be facing sideways to prevent flow through the opening to the sensor from being blocked by biofouling organisms. At vertical deployment sites the U-bolt of the meter cage is attached to an eye-pin cemented into the bay floor using a brass padlock. In case of possible lock failure, a heavy-duty cable tie is fitted between the U-bolt and eye-pin for extra support.



Figure 2.2.2.1: Horizontally Deployment of YSI Salinity Instruments

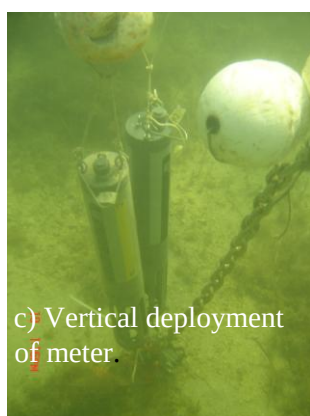


Figure 2.2.2.2: Different Instrument Deployment Arrangements

3.0 Calibration Procedures and Frequency

YSI Data Sonde calibration is an essential and integral part of the quality assurance plan. Instruments are targeted for retrieval and calibration on a tri-weekly schedule of deployment based primarily on weather. Deployment may extend to a four-week period if weather or other unforeseen problems arise. Before deployment, lab technicians verify that all instruments are in proper working condition and that batteries have the proper level of voltage prior to deployment (**Appendix A**). Battery voltage is noted on the calibration sheet.

The retrieved instruments are brought back to the lab for data upload to NPS computers, post calibration, cleaning and calibration (**Appendix B**). Retrieving instruments for cleaning and calibration in the laboratory ensures that the micro-fouling layer of bacteria and micro-algal growth are completely removed. Removal of this micro-algal layer ensures that it does not serve as a basis for further macrofouling, which could cause drift in data. After The YSI 6600 data sondes are calibrated, any preventative cosmetic maintenance is performed. Upon completion of any necessary maintenance the sondes are set for redeployment. General upkeep and maintenance is performed by project staff on a routine basis. Biscayne water quality project employees are YSI trained in routine maintenance and general preventive diagnosis. Regular maintenance includes: changing batteries, and or battery caps, replacing and lubricating O-rings, replacing probes and port plugs.

3.1 Instrument calibration

The sensor is placed in the same calibration standard used to calibrate the instrument (**Appendix B**). Temperature, specific conductivity, depth, and battery voltage are recorded onto the calibration sheet, which is later entered into the computer and associated with that particular filename and site. Cell constants are also reviewed to make sure they fall within the range of acceptability (5.0 +/- 0.5). Cell constants are recorded on the calibration sheet to track when sensors need to be replaced (Figure 3.1). Sondes are calibrated with the 50 mS/cm standard as a single point with a zero check on deionized distilled water from a Millipore Direct-Q Water Filtration System with a conductivity of 0.0 mS/cm. The 50 mS/cm standard is used because it is closer to the majority of salinity values that occur in the ecosystem and linearity is assured using the zero check. YSI specifications are that the conductivity sensor used is linear to 70 psu (Appendices C & D). Post calibration is done twice: once prior to the meter being cleaned of biofouling and then once after the meter has been cleaned. The meter is then recalibrated and if necessary, set up to record for the next set of sites.

CALIBRATION DATA SHEET

Date (mm/dd/yy) _____	Station Number _____	
Instrument Type _____	Sonde ID Number _____	
Lab Tech _____	Date Deployed _____	Set up by: _____

Calibration Information Conductivity Calibration Standard Value _____ Carbony Number _____ Sensor Reading _____ Zero Check _____ Cell Constant _____ Temperature ° Celsius _____ Depth/Pressure _____ Battery Voltage _____	Calibration Results _____ _____ _____ _____ _____ _____ _____	Post-Calibration Results <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">PreClean</th> <th style="width: 50%;">Clean</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> </tr> </tbody> </table>	PreClean	Clean	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
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_____	_____																	

Notes: _____

Date Post-Cal'd: _____
 By: _____

Sample Rate _____ MIN
 Delay Sample time _____ (EST)

DATE RECOVERED _____

Atmospheric Pressure		
Initial value	Ending value	Difference
_____	_____	_____

DATA FILE NAME _____

Processing Information To Be Filled in By ERDC

Sensor Offsets:	Pressure _____	Salinity _____
	_____	Temperature _____
Atmospheric Offset	_____	
	(ERDC)	

Figure 3.1: Calibration data sheet

3.1.1 Temperature

The temperature probe is checked during calibration using a laboratory traceable NIST Celsius thermometer. A temperature reading must be within ± 0.15 degrees Celsius to be acceptable. If the check does not meet these requirements, the sonde will be checked. If the sonde still does not prove correct, the associated data will be flagged and the unit will then be sent to the manufacturer for service. The temperature probe is also checked by the factory during maintenance and service of the instrument.

3.1.2 Conductivity

The conductivity probe is calibrated by filling the calibration cup with a conductivity standard and is adjusted to that value. Calibration procedures are based on and follow the manufacture YSI recommendations. The calibration is accepted if the sonde reads within $\pm 0.5\%$ of the true value of the standard. If the reading does not meet these limits, the problem will be determined and corrected. **Note:** Instruments measure conductance and temperature, from these readings the meter then calculates specific conductance and salinity. Conductivity is calibrated using one point. The YSI 6600 meets or exceeds advertised conductivity specifications with a single point calibration (**Appendix C**). However, a zero check is done with deionized water to ensure accurate calibration and is noted on the Calibration Sheet. In the event the zero check does not read zero, the meter is recalibrated.

3.1.3 Depth

Depth is determined using a pressure sensor. Barometric pressure, taken from a Princo Nova mercury barometer located in the laboratory is recorded on the calibration sheet and the depth is calibrated to 0 meters. Atmospheric pressure is noted to ensure the meters are responding throughout the expected measurement range. If an incorrect reading is observed, the sensor will be cleaned and rechecked. If the problem is not corrected by cleaning, the manufacturer is contacted for instructions/recommendations.

3.1.4 Weather Data

A portable weather instrument (Kestrel Pocket Weather Tracker) is used to record deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Wind direction, wave height and the meter identification number are also recorded onto field data sheets at each deployment site (**Figure 4.1.1**). All the data collected at deployment sites is entered into a database along with information about the calibration of each instrument used at every site. This facilitates QA/QC for an individual data sonde's repetitive malfunction due to site-specific or weather-related conditions. Time on the weather instrument is standardized to Eastern Standard Time at the beginning of each deployment trip with the atomic clock in Boulder Colorado.

3.2 Calibration Standards

The conductivity standard is purchased from YSI. The YSI conductivity standard, the 50 mS/cm standard, is traceable to the National Institute of Standards and Technology (NIST). As manufactured, it met or exceeded its current specifications (YSI Certificate of Traceability). The rinse water used in calibration procedures is de-ionized water obtained from a Millipore Direct-Q Water Filtration System with a conductivity of 0.0 mS/cm.

3.3 Instrument Calibration Records

Instrument calibration response is recorded on lab calibration sheets, which are then placed in the calibration logbook. BISC laboratory technicians maintain this logbook. The format for the calibration sheets is shown in **Figure 3.1**. This metadata is also entered into a Microsoft Office Access database. A checklist, shown in **Appendix B**, outlines step-by-step procedures used by BISC lab technicians during the calibration process.

4.0 Field and Laboratory Quality Control Checks

Quality control procedures are those steps taken by laboratory and field staff to insure accuracy in data collection and reliability of the data itself.

4.1 Field Quality Control Checks

Quality control checks performed in the field are the following:

1. Field sheets are used to record which sonde is being deployed and which sonde is being retrieved. Each sonde has a unique identification number displayed on the exterior in black marker corresponding to a unique YSI serial number (**Appendix D**). These field sheets are then placed in the field logbook. The format used for this data sheet is shown in **Figure 4.1.1**.
2. Field technicians are to verbally confirm sonde identification upon deployment and retrieval to another field technician in the boat who records this on a field sheet. A tape indicating the date of calibration and site of deployment is also attached to each instrument handle bail.
3. Sondes will be dual deployed for a minimum of four readings or 1 hour in order to have simultaneous data (four concurrent samples) recorded at each site. For each deployment before leaving the lab, field technicians check the clock in the laboratory for the correct time. Time is determined by the atomic clock in Boulder Colorado. Time is checked for the laboratory clock before each calibration and this value is then used in setting up the sondes for field deployment. This allows absolute knowledge of when the sonde is reading in the field and is used to determine the overlap period.
4. At horizontal deployments, the field technician must place the data sonde so that the conductivity probe is positioned on its side, not directly up or down (**Figure 2.2.2.2**). This prevents sediment from entering the probe and also keeps air bubbles from getting trapped in the probe. Only three sites remain with vertical deployment. In vertical deployment buoys are attached to the bail to hold the instrument vertical (**Figure 2.2.2.2**). Both methods of deployment have the instruments locked to the bottom with brass or stainless steel padlocks and held in place with plastic zip ties. Both methods of deployment allow the instrument to record at the same depth.

RETRIEVAL AND DEPLOYMENT OF BISCAYNE BAY YSI INSTRUMENTS

Date: _____	Field Techs: _____
Station #: _____	Instrument Type: _____ (6000, 6600, 600XLM)
Instrument ID: _____	Deployed: _____ (EST)
Instrument ID: _____	Retrieved: _____ (EST)
<u>Conditions at Deployment:</u>	<u>Conditions upon Retrieval:</u>
Air Temp (C): _____	Air Temp (C): _____
Barometric Pressure: _____	Barometric Pressure: _____
Est. Wave Height (ft): _____	Est. Wave Height (ft): _____
Wind Direction: _____	Wind Direction: _____
Wind Speed (k): _____	Wind Speed (k): _____
NOTES:	

***Air temperature, barometric pressure, and wind direction and speed measurements will be taken with a hand-held weather instrument.**

***This information will be entered**

Figure 4.1.1: Field data sheet

4.2 Laboratory Quality Control Checks

The lab technician is responsible for checking the field log for discrepancies in deployment or retrieval procedures upon downloading the data. It is also necessary to monitor individual instrument response documented in the calibration and/or maintenance logbook should such problems arise.

The procedures for post calibration check are the same as the calibration procedures shown in **Appendix B**. Post calibration procedures are performed after data is downloaded. Any variance is recorded on the original calibration sheet to show possible drift in the collected data. If a problem is

found during post calibration and cannot be resolved by the lab technician, the instrument will be removed from use and serviced. This is then documented in the maintenance log.

After calibration, a tape indicating the date of calibration is attached to the instrument handle and units are prepared for deployment. At this time the lab technician places the appropriate size protective cage over the probes.

5.0 Data Evaluation, Validation and Reporting

5.1 Data Evaluation and processing

Evaluation of the data occurs before the raw data is validated in the database. The purpose of this procedure is to ensure that the data being imported to the database was recording the correct location and that each parameter (temperature, conductivity, depth and salinity) is within acceptable limits of the instrument. This also confirms that the instrument is recording properly. This is accomplished using the following measures:

1. Lab technicians check calibration results to insure that data falls within acceptable limits based on parameter-specific instrument limits. This check is noted on the calibration sheet.
2. Results from the post calibration check will be compared to calibration readings and recorded on the calibration sheet.

The evaluation of data is accomplished through a series of reviews and checks (**Appendix E**). The results are reviewed by the technician performing the data download to spot any obvious errors and to confirm that the sonde is recording properly. After a final review the technician decides if the data is acceptable for final importation to the database for processing.

5.1.1 Importing Data

Several protocols have been applied to the datasets in order to improve accuracy and eliminate the potential for errors. Most of these changes are related to how the data is managed and altered after downloading. The aim of organizing the data is to create a complete dataset that spans a complete calendar year.

The first step in processing the data is downloading the data into a text file (**Table 5.1.1**). This allows the data to be ready to be uploaded directly on the Everglades National Park DataForEver Database without any changes in the data. This avoids the potential of additional errors of manipulating data to adjust format and make data corrections outside of the database. Only the actual data from the deployment is uploaded to the database. The readings before the deployment and after retrieval are not uploaded into the database.

Table 5.1.1. Example of data that is taken directly from a YSI.

Date m/d/y	Time hh:mm:ss	Temp C	SpCond mS/cm	Sal ppt	Depth meters	Battery volts
01/25/11	12:00:08	21.43	17.63	10.42	0.408	11.0
01/25/11	12:15:08	21.48	17.17	10.13	0.429	11.0
01/25/11	12:30:08	21.42	17.22	10.16	0.458	11.0
01/25/11	12:45:08	21.37	17.25	10.18	0.480	11.0
01/25/11	13:00:08	21.40	17.05	10.05	0.505	11.0
01/25/11	13:15:08	21.41	17.09	10.07	0.532	11.0
01/25/11	13:30:08	21.34	17.37	10.26	0.556	11.0
01/25/11	13:45:08	21.29	17.75	10.50	0.583	11.0
01/25/11	14:00:08	21.27	18.04	10.69	0.609	11.0
01/25/11	14:15:08	21.35	17.83	10.55	0.619	11.0
01/25/11	14:30:08	21.41	17.69	10.46	0.635	11.0

5.1.2 Graphing Data

Once data is uploaded to the database, data is graphed inside the DataForEver Database to help identify errors. Each sampling event is graphed and there is a graph for each of the major variables including temperature, salinity, specific conductivity, and depth versus time. The graphs produced from this step are used later for data interpolation. In addition, the graphs allow for easy detection of data points recorded prior to actual deployment, that were not deleted in the first step. Any data errors and obvious data problems can then be seen in this step. Any errors including battery failure or incorrect depth reading indicate that the data must be viewed much more closely. This could be seen for example if a top instrument falls out of the buoy and onto the bay floor then the depth will dramatically increase and so this information can then be deleted in the data validation step.

Since the data are generally consistent, these errors can usually be seen and fixed easily. Any changes that are made to the data based on the graphs are made in the database allowing us to keep track of changes that are made to the raw data. In this database any malfunction of the probes is also noted even if the data cannot be fixed, in this case the data is removed from final approved dataset and null values inserted. All Raw data and changes made to it are maintained in the database along with the approved, validated data.

5.2 Data Validation

The MAP's QA/QC consists of analytical data review and selection of a data output format to benefit other data users. Once the data file is uploaded to the South Florida Natural Resource Center's Database (DataForEver), it is reviewed for outliers and instrument malfunctions. In the event that there are single outlier data points in which one salinity data point suddenly decreases that are over +/- 5% around a linear regression of the data (to find outliers where the salinity increases are anomalies), canal discharge and rainfall measurements are checked to determine whether they would be the cause for the sudden change in salinity value. If a large rainfall or canal discharge was recorded a few days prior to the outlying data point, the data point will be retained.

Otherwise, the point is deleted. When data points from surface sites fall below the depth of zero, it is assumed that the meter came out of water during those readings so these data are disregarded unless these phenomena occurred at other instrument sites. If the pattern is the same at other sites, with depth values apparently appearing slightly above water surface, it is assumed that this was an atmospheric pressure phenomenon and these values are left in the data set. It is the BISC and EVER NPS operating procedure that well calibrated, well maintained instruments are assumed to collect good valid data unless proven otherwise. If a reason for the data value under consideration to be removed cannot be specifically identified, (eg. wildlife interaction, out of water, instrument malfunction, human error) then the data is retained.

Once the data file is QA/QC'd, null values are entered into empty time slots, and the data is run through Estimated Linear Interpolation. It is assumed that a newly deployed meter is reading correctly and that drift could have occurred in the retrieved meter. Using DataForEver database, the data are plotted to see whether the overlap in readings corresponds to the same pattern of increase/decrease in salinity. If the readings from the previous file match or follow the same pattern as the file that follows, the database uses the first reading of the deployed meter file to interpolate the drift that occurred between the first reading of the retrieved meter file and the last reading of the retrieved meter file. If the final reading of the previous retrieved meter file and the first reading of the deployed meter file do not match or follow the same pattern, the first (dirty) post-calibration reading is used to determine the linear interpolation. After 'Estimation Linear Interpolation' is completed, the data is validated. Data Validation performs two vital roles, it removes data that only the group collecting the data could identify as invalid, and it verifies a consistent data set that then can be made available to the public verified to within the specified parameters.

5.3 Data Reporting

All data is downloaded upon retrieval of the sondes. Raw data is stored on the NPS server, in hard copy, and on a CD. The raw data is saved through the Ecowatch program and then exported to a text file, readable without the Ecowatch software. These raw data files will be archived according to NPS standards using the proper file codes. All data will be available to project managers, lab technicians and the MAP program. All raw data is also retained on the DataForEver database as well.

6.0 Preventive Maintenance

6.1 Laboratory Maintenance

Cleaning and maintenance of all equipment is necessary to insure proper operation and reliable results. Regular maintenance on YSI instruments is only conducted by YSI representative trained employees. Regular maintenance includes changing batteries and/or battery caps, replacing o-rings, probes, and port plugs.

Changing Batteries- The instrument should be dried and placed on its side to prevent water or other substances from entering the battery compartment. The two screws on the top of the battery cap should be removed. Remove old batteries. Inspect the battery compartment for rust or other signs of failure. The battery cap should be examined for any failures, cleaned

and re-greased (YSI provided grease only). Install new batteries and then replace the cap with the associated gasket, ensuring cap is properly re-installed. Only tighten to a “snug fit” in order to prevent damage of the compartment and/or housing.

Replacing Battery Caps- Broken battery caps should be removed using the two screws. If the cap is unable to be removed due to damage send sonde to YSI. The new battery cap should be checked for proper fit, o-rings should be checked and greased (YSI provided lubricant only). Install new battery cap with new batteries. Only tighten to a “snug fit” in order to prevent damage of the compartment and/or housing.

Replacing O-rings- Old o-ring should be removed and the slot holding the o-ring should be cleaned. Install proper size o-ring, then grease with YSI lubricant.

Replacing Probes- Instrument should be dried and placed on its side to prevent water or other substances from entering the port. Old probe should be removed by unscrewing the fastener at the base of the probe using the YSI provided tool only. Once probe is removed check port and fitting for any moisture, corrosion, and/or other substances. Only if the port is clean, grease o-ring on probe and **carefully** install new probe only tightening to “snug fit”. Ensure proper working condition after calibration by performing a test run.

Replacing Port Plugs- Only replace port plugs which are broken or cracked. Instrument should be placed on its side to prevent water or other substances from entering the port. Dry and unscrew port plug. Dry inside port if necessary. Grease and install new port plug of same size. Tighten to “snug fit”.

6.2 Field Equipment Maintenance

Routine maintenance and cleaning of each data sonde is performed upon retrieval. Other field equipment used during deployment is cleaned at this time. These procedures are documented in the maintenance logbook.

Each sonde is externally brushed clean of biotic fouling while in the field, but this is only done in the area above the depth sensor. This allows both for the instrument to be cleaned and for any fouling on the sensors to be retained for the post calibration check. Before deployment, screws are greased with manufacturer supplied lubricant and external o-rings are visually checked for tearing and loss of elasticity. Battery replacement occurs when the voltage reads 10.5 volts or below. Should a malfunction occur or service be required, a detailed account of the problem is recorded in the maintenance logbook using the format shown in **Figure 6.1**. Instrument service and repair is contracted and sent to YSI if the laboratory technician cannot resolve the problem on site with the help of YSI staff. The corrections made by YSI are also documented in the maintenance log upon return of the serviced instrument to the Park. Instruments returned from maintenance are held in the lab underwater for a day and then double deployed with other instruments for at least one day to ensure that the problem has been corrected prior to an actual field deployment.

Other field equipment that must be maintained includes padlocks, wire cutters, GPS, and the Kestrel weather logger. These items are soaked in fresh water or wiped with a freshwater damped cloth upon returning to the lab. Locks are subsequently oven dried to remove any sand, The locks are then soaked in a lubricant, and exercised, and filled with grease.

Instrument Malfunction Log

Unit Number:

Date:

Reported by:

Problem Description:

Amendments or Adjustments:

Figure 6.1: Instrument malfunction Log

7.0 Reference

ERDC-WES-USACE, Final Draft Scope of Work: Time and Cost Estimate for Hydrodynamic Field Data Collection in Biscayne Bay, Revised BBCW Salinity Data Collection, December 15, 2003.

South Florida Water Management District, Field Sampling Quality Manual, Section 6, Field-Testing, October 9, 2002.

South Florida Water Management District, Generic Quality Assurance Plan prepared for DER and DHRS, Revision No. 2.2, February 1, 1990.

YSI 6-Series Multiparameter Water Quality Sondes User Manual, Revision E, April 2009

Appendix A

Sonde Set up

Open EcoWatch Software

Click on Sonde Icon

Select COM port window will appear- Click OK

Connect Sonde

Type in “menu” and press Enter

Main Menu will appear

Set up Time and Ensure that Date is correct (some instruments will be one day behind)

Select 4-Status

Select 3-Time

Enter time as appears on digital clock that is set to atomic clock (located in lab)

Push enter when times matches on your entry and clock

Check Free Memory- Must be more than 120 days

****If not: make sure files are uploaded and delete all files****

Go back to main menu (Esc)

Set up File/site name and Turn Instrument on

Select 1-Run

Select 2-Unattended sample

Select 5- File name: enter file name as appears on calibration sheet Site/Sonde

ID/Alphabetical Month/ day/ one digit year (for 2010= 0)

The naming convention for each data file is as follows: LL = site/location number, NN = sonde identification number, M = month represented by a letter, DD = day, Y = last digit of the year (See Appendix D)

Enter

Select 6-Site for site number and zone

Enter Site and Zone (ex 00 Z1)

Enter

Check 8-Batt life (should be more than 10V)

If not replace Batteries or do not deploy in field

Select C-Start logging

Select 1-Yes

Esc to exit

Instrument is Turned on and Logging

Ensure that cap is replaced properly and snug.

Re-Write on instrument the Sonde ID # as well as contact information.

Turn Off Meter (Returning from Field)

Open EcoWatch Software

Click on Sonde Icon

Select COM port window will appear- Click OK

Connect Sonde

Type in “menu” and press Enter

Main Menu will appear

Select 1- Run

Select 2- Unattended Sample

Select B- Stop logging

Esc to main menu

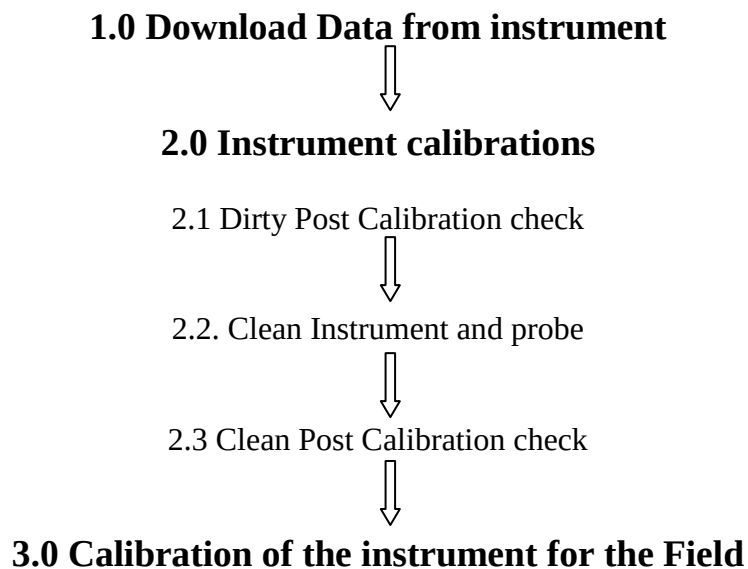
Disconnect Sonde

Appendix B

Sonde Calibration

Sondes are calibrated with the 50 mS/cm standard as a single point with a zero check on deionized distilled water from a Millipore Direct-Q Water Filtration System with a conductivity of 0.0 mS/cm. The 50 mS/cm standard is used because it is closer to the high values that occur in the ecosystem and linearity is assured using the zero check.

This flow chart is showing the basic steps to perform the sonde calibration



Open EcoWatch Software

1.0 Download Data from instrument

Click on Folder Icon

Select file location in R drive to upload the data

(R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data, select the correct year folder and select upload folder)

Click OK then click on Cancel

Click on Sonde Icon

Select COM port window will appear- Click OK

Connect Sonde

Type in “menu” and press Enter

Main Menu will appear

Select 3- File

2- Upload

** select the number of the corresponding file

1- Proceed

3- ASCII Text

Allow to Upload

Esc to main Menu

Record Pressure on Calibration Sheet and subtract difference to enter in third box

2.0 Instrument calibrations

2.1 Dirty Post Calibration check

Place Sonde in clamp

Rinse probe w/ dirty rinse cal cup

Run attended sample with Dirty run cal cup

Select 1- Run

Select 1- Discrete Sample

Select 1- Start Sampling

Allow to stabilize

Record values on Calibration sheet for that file

Esc to main menu

Disconnect sonde

2.2. Clean Instrument and probe

Clean Sonde and Probe

Dry probe

2.3 Clean Post Calibration check

Reconnect Sonde and place in Clamp

Rinse probe with clean rinse cal cup

Use clean run cal cup to run discrete sample

Allow to stabilize

Record readings on the correct calibration sheet
Esc to main menu

3.0 Calibration of the instrument

(Leave Sonde in clamp and in the clean run cal cup for calibration)

Get new Cal sheet from the Orange Cal sheet folder

From main menu

Select 2- Calibrate

Select 2- Pressure

When asked to enter depth in Sondes enter 0.0

Then press enter

Allow to stabilize then press enter again to start calibration

Press enter to verify calibration again

Select 1- Conductivity

Select 1- SpCond

Enter Sp Conductivity standard value (50)

Enter

Allow to run until stable then enter again to calibrate

Press enter when desired value is stable

Record values of calibration on new calibration sheet

****On new calibration sheet record pressure at time of calibration****

Rinse probe of calibrated Sonde in fresh water (fresh cal cup)

Dry probe

Use fresh cal cup to run discrete sample to determine 0 check

Esc to main menu

In order to record Cal constant:

Esc to main menu

Select 8- Advanced

Select 1- Cal constants

Record cond

Esc to main menu

Disconnect Sonde and label S/S handle with the calibration date

Place old Cal sheet in the Blue cal sheets to be entered folder

Place new cal sheet in the front of the black binder

Appendix C

Linearity/Accuracy of Conductivity Sensors on YSI 6-series sondes

YSI Technical Note

The conductivity sensors on YSI 6-Series sondes have excellent specifications with regard to stability and accuracy. The conductivity systems (circuit and probe) used with these instruments show typical accuracy of $\pm 0.5\%$ of the reading over a wide range (0-100 mS/cm), making it unnecessary for users to employ one probe for freshwater and a different probe for marine applications. Naturally, this accuracy specification requires proper user calibration with standards of high accuracy.

Like most conductivity systems, the circuitry employs a variety of ranges, but because of the YSI "autoranging" protocol, this feature is transparent to the user. Many manufacturers of conductivity meters and sensors provide an accuracy specification as a percent of range, while YSI's accuracy is quoted as percent of reading. The latter specification guarantees better accuracy at all conductivity values as evidenced by the following example:

A freshwater sample shows a conductivity of 800 $\mu\text{S}/\text{cm}$ that is read on a range of 0-5000 $\mu\text{S}/\text{cm}$ on two instruments, one which quotes accuracy as percent of reading and the other quoting accuracy as percent of range. Clearly the error for the former instrument is $0.005 \times 800 = 4$ $\mu\text{S}/\text{cm}$. However, the accuracy for the latter instrument is the same anywhere in the 0-5000 $\mu\text{S}/\text{cm}$ range and is $0.005 \times 5000 = 25$ $\mu\text{S}/\text{cm}$. Thus, for the percent of reading instrument the measured value is 800 ± 4 $\mu\text{S}/\text{cm}$ (0.5 %) while for the percent of range instrument the measured value is 800 ± 25 $\mu\text{S}/\text{cm}$ (3.1 %).

Note that, at the top of any range, the percent of range and percent of reading accuracy specifications are identical. However, for values less than the top of each range, the actual accuracy is always better for an instrument specified in the percent of reading protocol.

The same conductivity system is used on all EPG instruments (600R, 600XL, 6820, 6920, 600XLM, and 6000UPG). The following actual data were recorded using a Model 600R, but the results will be typical of all sondes. In the experiment, the sonde was placed in 10 mS/cm conductivity standard certified by YSI's Metrology unit to be accurate to $\pm 0.25\%$. The instrument was calibrated according to the instructions outlined in the manual and then several instrument readings recorded at a 1 minute sample interval to demonstrate the system stability. The sensor was carefully rinsed with deionized water and then dried. The sonde was then placed in 1.0 mS/cm standard certified to be accurate to $\pm 0.5\%$ and the instrument readings recorded, with the actual value and stability noted. The rinse-dry cycle was repeated and then the sonde was placed in 50 mS/cm standard certified to be accurate to $\pm 0.25\%$ and the readings again recorded. The data are shown in the Table below.

Time, minutes	Actual Specific Conductance, mS/cm	Temperature, C	Measured Specific Conductance, mS/cm	% Error
0	10.00 $\pm$ 0.25%	25.1	10.00	0.0
1	10.00 $\pm$ 0.25%	25.1	10.00	0.0
2	10.00 $\pm$ 0.25%	25.1	10.00	0.0
3	10.00 $\pm$ 0.25%	25.1	10.00	0.0
4	1.00 $\pm$ 0.5%	24.8	1.000	0.0
5	1.00 $\pm$ 0.5%	24.9	1.000	0.0
6	1.00 $\pm$ 0.5%	24.9	1.000	0.0
7	1.00 $\pm$ 0.5%	24.9	1.000	0.0
8	1.00 $\pm$ 0.5%	24.9	1.000	0.0
9	10.00 $\pm$ 0.25%	24.9	49.79	0.42
10	50.00 $\pm$ 0.25%	24.9	49.79	0.42
11	50.00 $\pm$ 0.25%	24.9	49.80	0.5
12	50.00 $\pm$ 0.25%	25.0	49.81	0.38
13	50.00 $\pm$ 0.25%	24.9	49.82	0.36
14	50.00 $\pm$ 0.25%	24.9	49.81	0.38
15	50.00 $\pm$ 0.25%	24.9	49.82	0.36
16	50.00 $\pm$ 0.25%	24.9	49.82	0.36
17	50.00 $\pm$ 0.25%	24.9	49.82	0.36

As can be seen from the data, all readings are within the quoted typical accuracy specification of the conductivity system ($\pm$ 0.5 % of reading) after calibration of the system at 10 mS/cm, and also show excellent stability.

It must be remembered that a great deal of care was taken in this experiment:

- 1 - The sensor was carefully rinsed and dried prior to changing standards;
- 2 - High quality standards were used;
- 3 -The readings were taken under controlled temperature conditions close to 25° C (where the standard accuracy is specified) to minimize any temperature compensation errors;
- 4 - The sensor was new with perfectly clean electrodes.

A compromise of any of these factors could have resulted in readings that were apparently outside of the accuracy specification.

Note: YSI quotes typical accuracy specifications for all sensors that we believe characterize most of our instruments.

The data shown above, as well as additional conductivity data that supports the accuracy specification, are from internal YSI studies.

Appendix D

Meter Identification Numbers and Month Naming Convention

Data Sonde Serial Number		BISC ID Number	Sonde Type
02H 1078	AB	12	6600
02H 1078	AA	05	6600
01J 0554	AB	11	6600
01J 0554	AA	10	6600
03H 1584	AA	31	6600
	AB	32	6600
	AD	34	6600
	AE	35	6600
	AF	36	6600
03H 1510	AA	37	6600
	AB	38	6600
	AC	39	6600
	AE	41	6600
03J 0442	AC	44	6600
	AE	46	6600
03J 0543	AB	48	6600
	AC	49	6600
	AE	51	6600
03J 0611	AA	52	6600
	AB	53	6600
	AC	54	6600
	AE	56	6600
03J 0675	AA	57	6600
	AC	59	6600
03H 2003	AA	60	6600
	AB	61	6600
03L 0206	AB	63	6600
	AD	65	6600
	AE	66	6600
03L 0335	AA	67	6600
	AB	68	6600
03L 0420	AA	69	6600
	AC	71	6600
04H 14346	AA	73	6600
	AD	76	6600
04H 14776	AA	77	6600
	AB	78	6600

Data Sonde Serial Number		BISC ID Number	Sonde Type
04H 14806	AA	79	6600
	AB	80	6600
05E 1443	AA	81	6600
	AB	82	6600
	AC	83	6600
	AD	84	6600
04K 17392	AA	85	6600
04J 15024	AA	87	6600
04J 15025	AA	89	6600
04J 15215	AA	91	6600
	AB	92	6600
05E 1534		93	6600
	AB	94	6600
	AC	95	6600
	AD	96	6600
05E 1753	AA	97	6600
	AB	98	6600
	AC	99	6600
	AD	100	6600
	AE	101	6600
05H 1028	AA	D0	6600
	AB	D1	6600
	AC	D2	6600
05H 1466	AB	D4	6600
	AC	D5	6600
05L 1798	AB	D6	6600
	AC	D7	6600
	AD	D8	6600
05H 1747	AA	D9	6600
05L 1578	AA	E0	6600
	AB	E1	6600
	AC	E2	6600
	AD	E3	6600
	AE	E4	6600
05L 1798	AA	E5	6600

Data Sonde Serial Number		BISC ID Number	Sonde Type
07F 101923		E6	6600
07F 101924		E7	6600
07F 101925		E8	6600
07F 101926		E9	6600
07F 101927		F0	6600
07G 100351		F1	6600V2-4
07G 100352		F2	6600V2-4
07J 101519		F3	6600V2-4
09J 101739		F4	6600V2-4
09J 101740		F5	6600V2-4
09J 101741		F6	6600V2-4
09J 101574		F7	6600V2-4
09J 101575		F8	6600V2-4
09J 101576		F9	6600V2-4
09J 101577		G0	6600V2-4
10J 100053		G1	6600V2-4
10J 100054		G2	6600V2-4

Month Naming Convention

January = A	July = G
February = B	August = H
March = C	September = I
April = D	October = J
May = E	November = K
June = F	December = L

AppendixE

Methods for Data Management

Table of Contents

- I. Introduction
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- VI. Important things to be careful about
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- VIII. Directory of folders and files

I. INTRODUCTION

There have been several changes that have been proposed and implemented to the newer datasets that will eventually be adapted to the older datasets in order to improve accuracy of the data. Most of these changes are related to how the data was managed and altered after downloading. The aim of organizing the data is to create a complete dataset covering a complete calendar year.

The first step involved with the data is to download the data in a text file. The reason for this is the data is ready to be uploaded directly on the DataForEver Database without any changes in the data, avoiding the potential of additional errors. At this point the data that was recorded before and after the sonde was deployed is deleted.

Data is kept on the sonde until less than 120 days of the memory is remaining and then data is deleted after careful check of the downloaded data. Each text file corresponds to one deployment and is uploaded the ForEver Database.

The data from the sampling events is imported into a Microsoft Access spreadsheet for the specific site.

QAQC

From this point the data is graphed to help identify errors. Each sampling event is graphed into the database. There is a graph for each of the major variables including temperature, salinity, specific conductivity, depth versus time. The graphs produced from this step are used later on for data interpolation. In addition, the graphs allow for easy detection of data points recorded prior to actual deployment, that were not deleted. These can be easily seen since their depths are at zero. For instance, the top meter falls out of the buoy and onto the bay floor. When this occurs, the depth will dramatically increase and can then be deleted. Since the variables are so different these errors can usually be seen and fixed easily. Any changes in the data based on the graphs is then inputted into a database that will allow us to keep track of what changes needed to be done to the data. In this database any malfunction of the probes is also noted even if they can't be fixed.

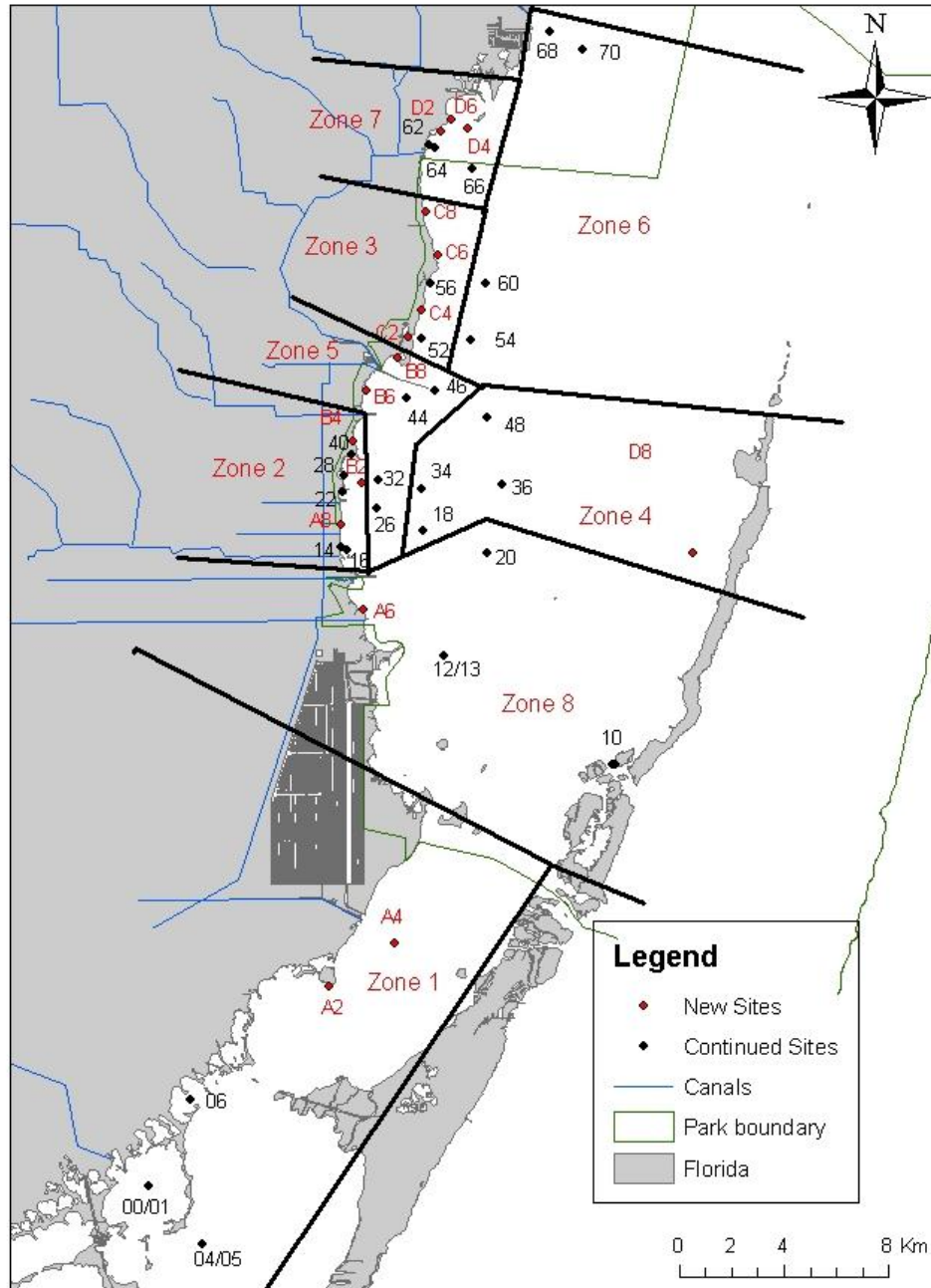
Validating Data

The data is then sent to DataForEver website to be validated. The data is uploaded to the database site that allows for specific conductivity and salinity variables to be calibrated based on the data from the sampling event immediately after it. This is important since the data over time may be affected by biofouling. This comparison is done by assuming that the first few data points are correct from each sampling event since these instruments were just calibrated. Since there are a few overlapping data points between sampling events, the difference between those points can show how much the data has deteriorated. A linear regression can be used to correct this issue. However, if the data points do not overlap then the information from the pre and post calibration will be used. A linear regression can be made by how much the pre and post calibration varied. Once the data has been altered it is now ready to be used by the public. The Everglades webpage has a program that easily produces graphs. The steps in the everglades webpage include importing data, adding null values, calibrating and validating the data. Attached are in-depth instructions for all of the processes listed above.

II. DEFINITIONS

1. **Filename** = is the name of a site over sampling period covering one specific meter. It is in the aabbcmmmy where aa is the site number, bb is the instrument id, c is the month as it corresponds to letters (a= January, b= February, c= March, etc.), mm is equal to the months and y is the last number of the year. Example 0199A306
2. **DAT file** = is the raw data file (downloaded directly from YSI meter)
3. **Text file** = is a text file based on raw data
4. **Configuration file** = is the file that describes how the text file was made
5. **SpCond** = is the specific conductivity of the site
6. **Site** = is the specific location where a meter is deployed
7. **Master file** = this is the main file in access. It contains all of the filenames in them. It is always named with the number corresponding to site. Ex. 00
8. **Sigmaplot** = the graphing program used to compare the overlap measurements between 2 meters
9. **DataforEver** = is the server that we use from the Everglades to manipulate the data and send of to DBHydro
10. **DBHydro** = the SFWMD website that houses our data that is available to the public
11. **Variables** = the parameters that you are studying (ex depth, salinity, specific conductivity and temperature)
12. **Calibration Standards** – this is the standard solution that is used for the calibration of the instruments. This is currently a carboy of gulfstream that we have calibrated at FIU.
13. **Station Datatype** = this is a name used in the EVER server. It means the site number and the specific variable to be used.
14. **Null values** = spaces in data when data was not taken but should have been taken. Most stat programs and graphing programs need these spaces to be blank thus null values must be inserted into them

III. Map of sites used in 2010-2011



IV. STEPS FOR COMPLETING THE SITE DATA VALIDATION FORMS

Several protocols have been implemented to datasets in order to improve accuracy of the data. Most of these changes are related to how the data is managed and altered after downloading. The aim of organizing the data is to create a complete dataset that spans a complete calendar year.

1. Download the data from the sonde into a text file

Table 1. Example of data that is taken directly from a YSI.

Date m/d/y	Time hh:mm:ss	Temp C	SpCond mS/cm	sal ppt	Depth meters	Battery volts
01/25/11	12:00:08	21.43	17.63	10.42	0.408	11.0
01/25/11	12:15:08	21.48	17.17	10.13	0.429	11.0
01/25/11	12:30:08	21.42	17.22	10.16	0.458	11.0
01/25/11	12:45:08	21.37	17.25	10.18	0.480	11.0
01/25/11	13:00:08	21.40	17.05	10.05	0.505	11.0
01/25/11	13:15:08	21.41	17.09	10.07	0.532	11.0
01/25/11	13:30:08	21.34	17.37	10.26	0.556	11.0
01/25/11	13:45:08	21.29	17.75	10.50	0.583	11.0
01/25/11	14:00:08	21.27	18.04	10.69	0.609	11.0
01/25/11	14:15:08	21.35	17.83	10.55	0.619	11.0
01/25/11	14:30:08	21.41	17.69	10.46	0.635	11.0

2. Fill out the following Site Data-Validation Forms for each site using the uploaded text file containing the raw data from the sonde

Filename	Data Load						Interpolation			
	Begin Date	Begin Time (+15)	End Date	End Time	Data entered to server	Graph	Begin time	Begin Cond	Interpolation	validated

- Write down filename, beginning date and time, ending date and time and beginning conductivity
- Once the data load and interpolation columns are completed, upload the data into the database and check mark the corresponding column
- Graph each parameters (temperature, depth and conductivity) and check mark the corresponding column
- Complete the following line by enter entering the next file corresponding to the next cycle to be able to do the interpolation.
- When the interpolation and validation are done, check mark the corresponding columns

V. STEPS FOR IMPORTING DATA INTO SERVER

Make sure the Site Data-Validation Forms are completed.

Open the EVER webpage <http://165.83.96.34>

1. Loading Data into the Server

- In the EVER webpage select [Load Biscayne YSI Data](#)
- On filename select browse and select the text file containing the wanted data
- Select the Biscayne Station, beginning and ending date and times to cover the range of the filename you wish to import using the Site Data-Validation Form
- Under change existing data select yes
- Under really select no and submit to make sure dates and times are correct
- Change really to yes and submit
- Check mark the column data entered to server on the Site Data-Validation Form

The screenshot shows the 'DataForEVER Hydrology' web interface. The main form is titled 'Load Biscayne YSI Data'. It contains the following fields and controls:

- Filename:** A text box with 'R:\Water Quality\Water Quality Gro...' and a 'Browse...' button.
- Biscayne Station:** A dropdown menu with 'BISC18' selected.
- Begin Date:** A date field with '2010-09-01' and a calendar icon.
- Begin Time:** A time field with '1145' and a format indicator 'Format: HHMM'.
- End Date:** A date field with '2011-04-10' and a calendar icon.
- End Time:** A time field with '1245' and a format indicator 'Format: HHMM'.
- Change Existing Data yn:** A dropdown menu with 'Yes' selected.
- Really yn:** A dropdown menu with 'Select' selected.
- Buttons:** 'Submit' and 'Reset' buttons.
- Message:** 'Do you really want to execute this PROCESS?'.

Numbered callouts point to specific elements:

1. Select Load Biscayne YSI Data (points to the form title)
2. Select Browse and find the text file (points to the 'Browse...' button)
3. Select the Biscayne Station (points to the 'Biscayne Station' dropdown)
4. Select beginning date (points to the 'Begin Date' field)
5. Select beginning time (points to the 'Begin Time' field)
6. Select ending date (points to the 'End Date' field)
7. Select ending time (points to the 'End Time' field)
8. Under Change existing data select Yes (points to the 'Change Existing Data yn' dropdown)
9. Select no and submit, double check to make sure values are correct (points to the 'Really yn' dropdown)
10. Change Really to yes and click Submit (points to the 'Submit' button)

2. Create graph to make sure data was entered correctly

- In the EVER webpage select [Output Merged Datasets](#)
- Select the station and submit
- Select the station datatype one by one (temperature, depth and conductivity)
- Enter beginning and ending date
- Under aggregate level select real time
- Under output medium select gracechart and submit
- Check mark the column graph on the Site Data-Validation Form

The screenshot shows the 'DataForEVER Hydrology' web application in a Windows Internet Explorer browser. The page title is 'Output Merged Datasets'. The form contains the following fields and options:

- Station Datatype:** A list box containing 'BISC12-Cond2[MS/Cm]', 'BISC12-Conductivity[MS/Cm]', 'BISC12-Data[]', 'BISC12-Depth[Meters]', 'BISC12-Oxygen Solubility[Mg/L]', 'BISC12-Salinity[Ppt]', and 'BISC12-Salinity Raw[Ppt]'. An 'Add ->' button is next to it.
- Begin Date:** A date field set to '2010-09-01'.
- End Date:** A date field set to '2011-04-10'.
- Aggregate Level:** A dropdown menu set to 'Real Time'.
- Output Medium:** A dropdown menu set to 'Gracechart'.
- Display Count yn:** A dropdown menu set to 'Select'.
- Omit Output If Any Missing yn:** A dropdown menu set to 'No'.
- Buttons:** 'Submit', 'Reset', 'Help', and 'Back to Prelookup'.

Numbered callouts point to the following elements:

1. Select Output Merged Dataset (points to the 'Output Merged Datasets' link in the left sidebar)
2. Select station and submit (points to the 'Station Datatype' list box)
3. Select Station Datatype and click Add (points to the 'Add ->' button)
4. Select beginning date (points to the 'Begin Date' field)
5. Select ending date (points to the 'End Date' field)
6. Select Real Time (points to the 'Aggregate Level' dropdown)
7. Select Gracechart (points to the 'Output Medium' dropdown)
8. Leave Blank (points to the 'Display Count yn' dropdown)
4. Click Submit (points to the 'Submit' button)

3. Check if there are any gaps in the data

- In the EVER webpage select [Missing Data Blocks](#)
- Select the station datatype
- Enter the beginning and ending date
- Under count per day enter 96 (there are 96 fifteen minute intervals in a day)
- Click submit (this will list off the number of blocks in the data. There should only be one if there is more than one then there is a gap in the data and you need to add in null measurement)

Missing Data Blocks

This process will produce a report of blocks of continuous data. Use to find if there is any missing data in the chosen time period

Station Datatype: BISC12-Bottom Temperature[Celsius]

Begin Date: 2010-09-01

End Date: 2011-04-10

Count Per Day: 96

Format: YYYY-MM-DD

Format: YYYY-MM-DD

How many times per day is this datatype measured at this station

Submit Reset

1. Select Missing Data Blocks

2. Select Station Name and Datatype

3. Select Beginning Date

4. Select Ending Date

5. Number of counts will always be 96

6. Click Submit

Measurement Null Value Insert

Missing Data Blocks

Missing Or Null Blocks

Output Annual Comparison

Output Annual Periods

Output Compare Stations

Output Custom Chart

Output Daily Moving Statistic

Output Exceedance Curve

Output Measurement Sets

Output Measurements

BISC12 bottom_temperature

2010-09-01|0000|28.9900|block_start

2011-02-07|1415|25.0200|block_end

4. Inserting a null value measurement (used to fill in gaps)

- In the EVER webpage select [Measurement Null Value Insert](#)
- Select the station datatype
- Enter the beginning date and time of the cycle
- Enter the ending date and time of the cycle
- Under Reason for missing value, list the reason for the gap
- Under Delete yn select no (this allows you to replace all the missing data in the time frame with a null value)
- Under Really select yes (Really yes makes changes, no allows you to see changes without making them permanent)
- Click submit

1. Select Measurement Null Value Insert

2. Select station and datatype

3. Select Beginning Date

4. Select Beginning time

5. Select Ending date

6. Select Ending Time

7. Select reason for value missing

8. Under Delete yn, always select no otherwise it will override all data

9. Click Submit

Station	Datatype	Begin Date	Begin Time	End Date	End Time	Reason Value Missing	Minutes Offset	Delete yn	Really yn
BISC44	Depth	2005-07-29	1230	2005-07-29	1245	Power Failure		No	Select

5. Interpolation of the data

Now the data is ready to be calibrated. Here is the rational behind calibrations. The data is assumed to be accurate when it is first deployed. However over time the signal may degrade (all scientific equipment does this). To compensate for this we have instruments overlap so we can estimate how much the meter may have degraded. The difference in the overlap is how much the instrument degraded during the cycle. This is then linearly regressed with the starting point being the beginning data (unchanged) and the end of the data being altered the most. This only works if the meter ran the whole time. Sometimes this does not happen. When there is an interruption in the data stream, we use the dirty/clean calibration data sheets. This is why we collect the dirty/clean post deployment data. This data show how much the instrument has changed from before it was brought out to the site to when it was brought back in. This difference is used when the sites did not overlap or if it is obvious that some other meter malfunction has occurred.

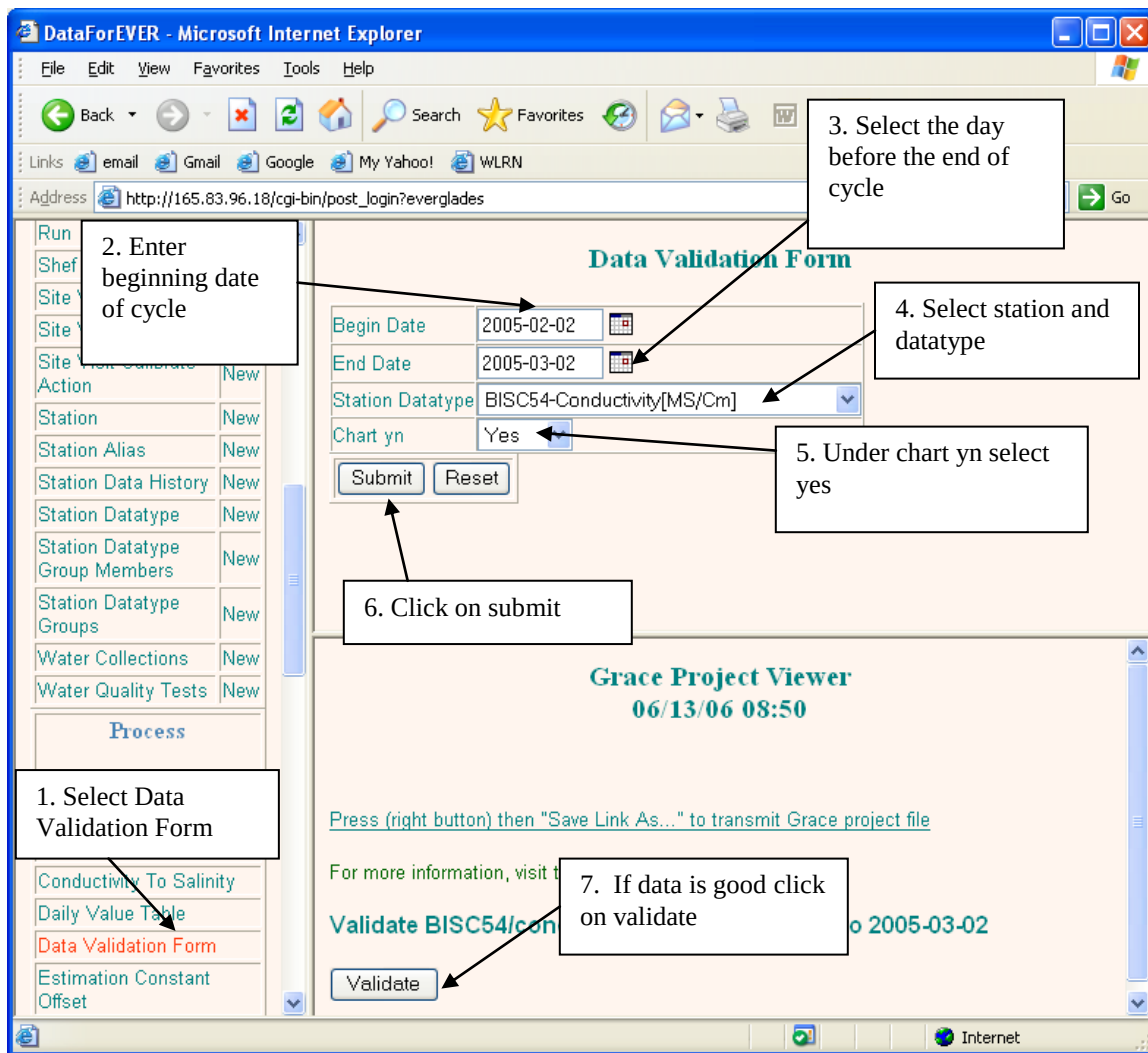
- In the EVER webpage select [Estimation Linear Interpolation](#)
- Under Process select linear interpolation drift
- Select the station datatype
- Enter the beginning and ending dates and times (Site Data-Validation Form)
- Enter first and last values (Site Data-Validation Form)
- Under Notes write ion sop for standard operating procedure
- Under chart select no
- Under really select no
- Click on submit (in the bottom window make sure beginning and ending times are correct, make sure first value is the same)
- Change really to yes and submit
- Check mark the column interpolation on the Site Data-Validation Form

The screenshot shows the 'Estimation Linear Interpolation' form in the DataForEver application. The form includes fields for Process, Station Datatype, Measurement Date, Measurement Time, First Value, Last Value, First Multiplier, Last Multiplier, Notes, Override Destination, Validation Requirement, Chart, and Really. Numbered callouts provide instructions for each step:

1. Select Estimation Linear Interpolation
2. Select linear interpolation drift
3. Select station and datatype
4. Select between
5. Select beginning and ending date
6. Select beginning and ending time
7. Select first value and last value
8. Under Notes write in sop for standard operating procedure
9. Under Chart yn select no
10. Select no and submit, double check to make sure values are correct
11. Change Really to yes and click Submit

6. Validation of the data

- In the EVER webpage select [Data Validation Form](#)
- Enter the beginning date of the cycle
- Enter the ending date but 1 day **before** the ending date of the cycle
- Under station datatype select the one to be validated (temperature, depth and conductivity)
- Under chart select yes
- Click on submit
- Review the chart to make sure the data is correct
- On the bottom screen select validate
- Check mark the column validated on the Site Data-Validation Form



VI. IMPORTANT THINGS TO BE CAREFUL ABOUT

1. Never delete a raw data file. Even if you know for a fact the data is bad. The raw data files are the text files or dat files that are directly downloaded off the data sonde. Bad data files include any file that you are not going to use because it has unreadable data, no data, known bad data, and sondes that were may have been mislabeled by site with some other form of questionable data. While the datafiles are deleted off of the sondes, they are saved on the computer in the pc6000 folder.
2. If the YSI datasonde is mislabeled and dropped off at the wrong site, the filename on the YSI needs to be downloaded then renamed to the correct site it was left at. However the incorrect name will still remain in the YSI datasonde memory.
3. When working on the Everglades Server, if you use the "measurement" function be careful what data you are deleting. **This function PERMANENTLY REMOVES THE DATA FROM THE SERVER and you cannot access them again.** If you accidentally delete it you will need to re-import the data.

VII. TROUBLESHOOTING

I. Graphing Errors

1. If an entire dataset is significantly off- this may mean that either you graphed the wrong data or you graphed the wrong site
2. If the beginning and ends of data are really off. This means that you did not delete the data that was recorded on the datasonde before it was deployed. You need to delete it for not just that datatype but for all the datatypes in that site. If there is an overlap you need to re-input the data from the overlapping dataset to fill the whole.
3. If the spcond sharply goes down to 0. This can be caused by the meter drying out especially during low tide. Check the depth if it goes down below 0 you need to delete it.

II. Errors in the insert null value.

1. These are the rarest of errors. If you accidentally set the data range to an improper date or time it is not a big deal. Just ignore it
2. If you accidentally select y for delete values you need to delete the range and re-input the data
3. If you get an error message that says no data collection frequency you need to set the data up to have a data collection frequency. Select data collection frequency, select a date before any of the data that you have existed along with a time. For the count select 96. This is the total number of times the meter makes a measurement per day. Then do insert null value again.

III. Errors in Involved During Estimating Linear Interpolation

1. If the first row data does not match.
 - a. Double check the Site Data-Validation Forms and make sure you entered them correctly
 - b. Check to make sure the information on the Site Data-Validation Forms is correct. Open up the text file and double check to make sure the values are correct.
 - c. If the data on the server is not similar to either of them then you have the wrong data inputted into the server. Delete the data and reenter it.
 - d. If the data on the server does not match the data on the overlap at all then you imported the wrong data, so delete it and reimport it

VIII. DIRECTORY OF FILES AND FOLDERS

1. Raw Data Files (DAT files)– are in the pc6000 folder
R:\Water Quality\Pc6000 DATA
2. Configuration Settings – are in the pc 6000 folder
R:\Water Quality\Pc6000 DATA
3. Text files (.txt) are in the pc6000 folder
R:\Water Quality\Pc6000 DATA
4. Data that has just been downloaded (DAT, Configuration Settings and text files)
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**\Uploaded Data
5. All excel sheets, access sheets, graphs and instructions for water quality project are in the SalinityProjectInfo folder
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**
6. Excel Sheets – are sheets that contain the data from the raw data files
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**\excel
7. Access files – are spreadsheets that contain calibration and field data in the access form
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**
8. The sigmaplot graphs are located in the folder graphs
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**\Graphs
9. Cvs sheets. Files calibration sheets are stored in the calibration folder.
 - a. The calibration sheets are stored in
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**\Calibration\Data Entry
 - b. The cvs files are stored in
R:\Water Quality\Water Quality Group\SalinityProjectInfo\Data\WQ_YSI_20**\Calibration

Appendix F

Data Error Categories

Data Error Categories

Error categories are developed from observations of an earlier salinity sampling program run for the Army Corps of Engineers (ACOE) by BISC in the middle 1990's and from observation of the existing program. Most errors are from the earlier sampling project and the existing sampling system has been designed to remove these sources of error as much as possible.

Machine Error

Possible machine errors include the following: 1) Instruments losing battery power before being retrieved; 2) Low battery power resulting in occasional loss of measurements or intermittent measurements; 3) Shifts in sampling time; Meters are set up to take measurements every 15 minutes. The correct timing for these measurements is 0:00, 0:15, 0:30, and 0:45. Occasionally the instruments can drift from this schedule, usually by small increments, and the sampling schedule can change. This has rarely been observed in the current data set. Machine error can also be due to electronic failure or in some cases probe failure with temperature and conductivity being out of the specifications range.

Environmental Error

Historically, in earlier salinity sampling programs review of this work showed that environmental errors can be due to instrument drift likely resulting from organismal use of the sensor or biofouling. Biofouling may be due to but not limited to microalgal or bacterial colonization of the instrument or from macro organisms such as barnacles, tunicates, bryozoans, worms, or mollusks. In some areas of the bay, large clumps of drift algae tumble along the bottom of the water column. When this group of algae gets caught on an instrument, it allows organisms to move in and out of the sensor and may affect the data. The sampling protocol currently employed provides for the instrument to be cleaned and recalibrated in the laboratory rather than in the field. This removes micro encrustations that serve as the basis for further fouling so that all fouling growth starts in the lag phase and so takes much longer to build up the more destructive macro organismal components. This has been very successful and except for very rare and unusual cases all of our deployments have met the 5% criteria for drift.

Personnel Error

Personnel error in historical data collection efforts have included: 1) Data set duplication, some data sets were downloaded twice, creating two files containing the same information; and 2) Data being downloaded into the wrong folder or not being downloaded. This can cause data to be lost or need to be re-downloaded. Instruments deployed at the wrong site.

Appendix G

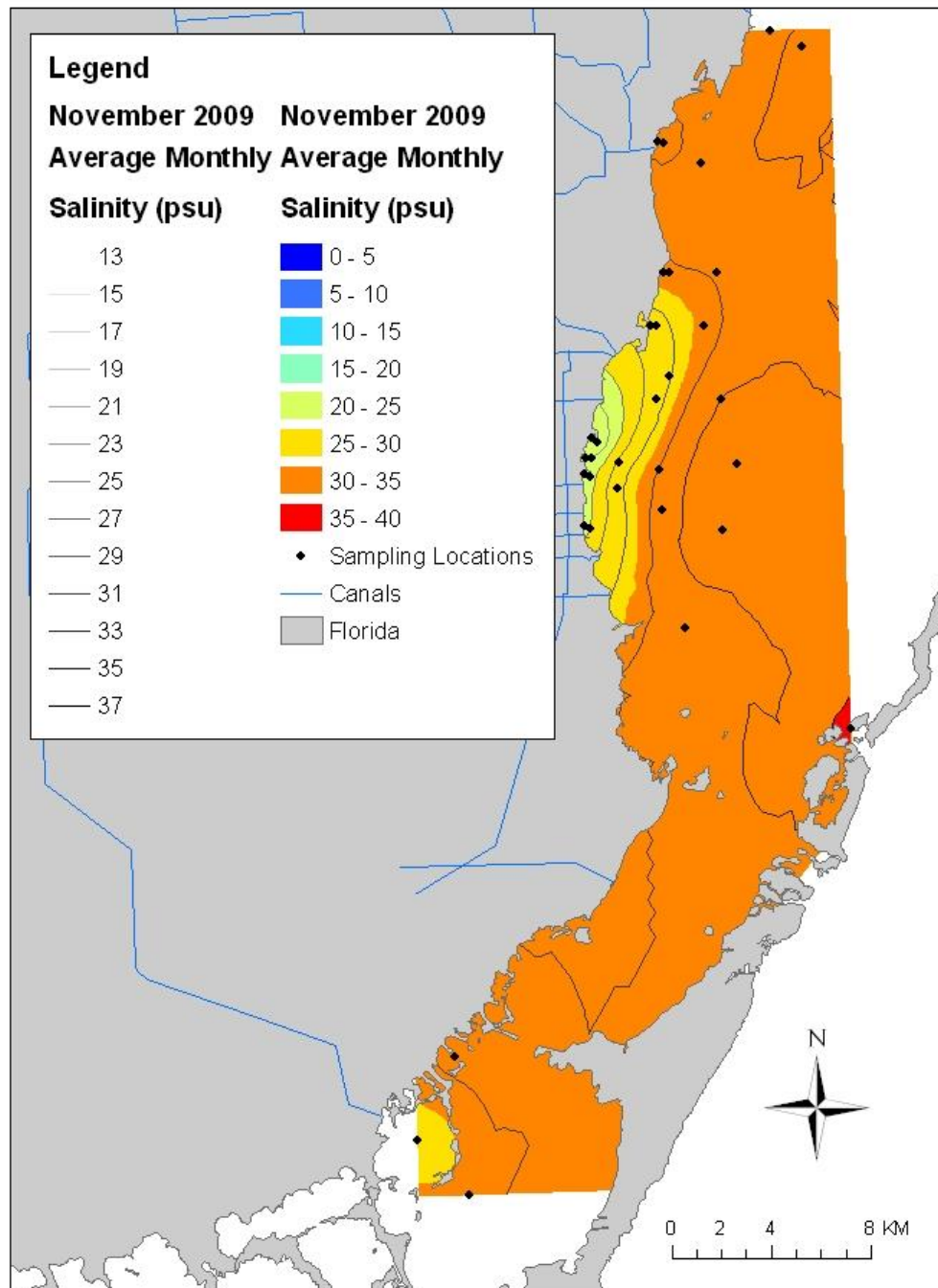
Sensor Specifications

YSI 6600 Data Sonde	
Available Sensors:	Temperature, Conductivity, Dissolved Oxygen, pH, ORP, Ammonium, Nitrate, Chloride, Depth (shallow, medium, deep, shallow vented), Turbidity, Chlorophyll and Rhodamine WT
Operating Environment Medium: Temperature: Depth:	Fresh, Sea, or Polluted Water -5 to +45 °C 0 to 656 feet (200 meters)
Storage Temperature:	-40 to +60 °C for sonde and all sensors except pH and pH/ORP -20 to +60 °C for pH and pH/ORP sensors
Material:	PVC, Stainless Steel
Diameter:	3.5 inches (8.9 cm)
Length:	19.6 inches (49.8 cm) with no depth, 21.6 inches (54.9 cm) with depth
Weight:	7 pounds (3.18kg) with depth and batteries but no added bottom weight
Computer Interface:	RS-232C, SDI-12
Internal Logging Memory Size:	384 kilobytes (150,000 individual parameter readings)
Power:	8 C-size Alkaline Batteries or External 12 VDC
Battery Life:	Approximately 290 days at 20 C at 15 minute logging intervals, a 40 second DO warm up time, and turbidity and chlorophyll active

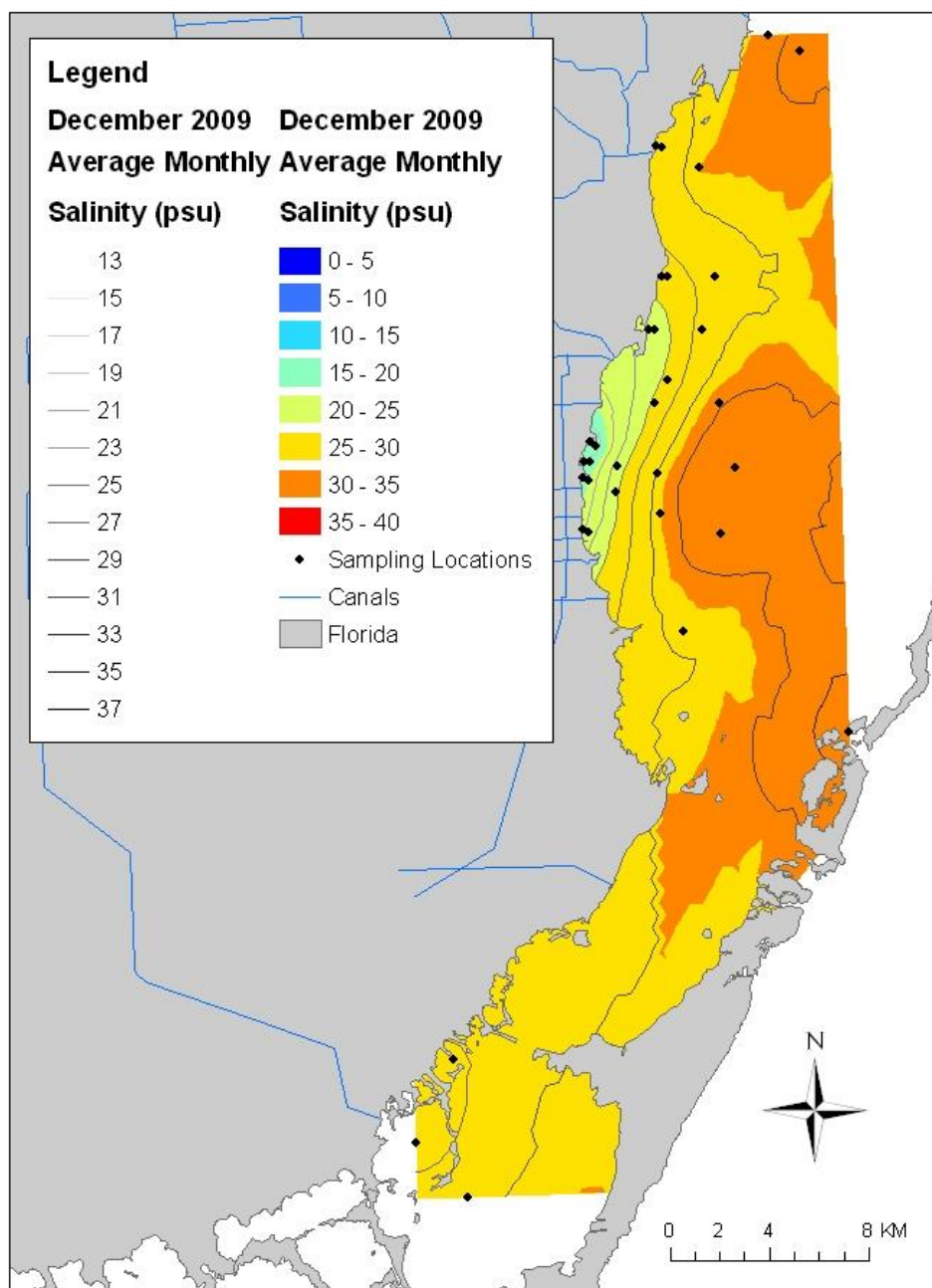
Performance Specifications:	
Non-vented Level-Shallow	
Sensor Type:	Stainless steel strain gauge
Range:	0 to 30 feet (9.1 meters)
Accuracy:	+/- 0.06 feet (0.018 meters)
Resolution:	0.001 feet (0.001 meters)
Temperature:	
Sensor Type:	Thermistor
Range:	-5 to 45 °C
Accuracy:	+/- 0.15 °C
Resolution:	0.01 °C
Depth:	200 meters
Salinity:	

Sensor Type:	Calculated from conductivity and temperature
Range:	0 to 70 ppt
Accuracy:	+/- 1.0% of reading or 0.1 ppt, whichever is greater
Resolution:	0.01 ppt
Conductivity:	
Sensor Type:	4 electrode cell with autoranging
Range:	0 to 100 mS/cm
Accuracy:	+/- 0.5% of reading + 0.001 mS/cm
Resolution:	0.001 mS/cm to 0.1 mS/cm (range dependent)
Depth:	200 meters

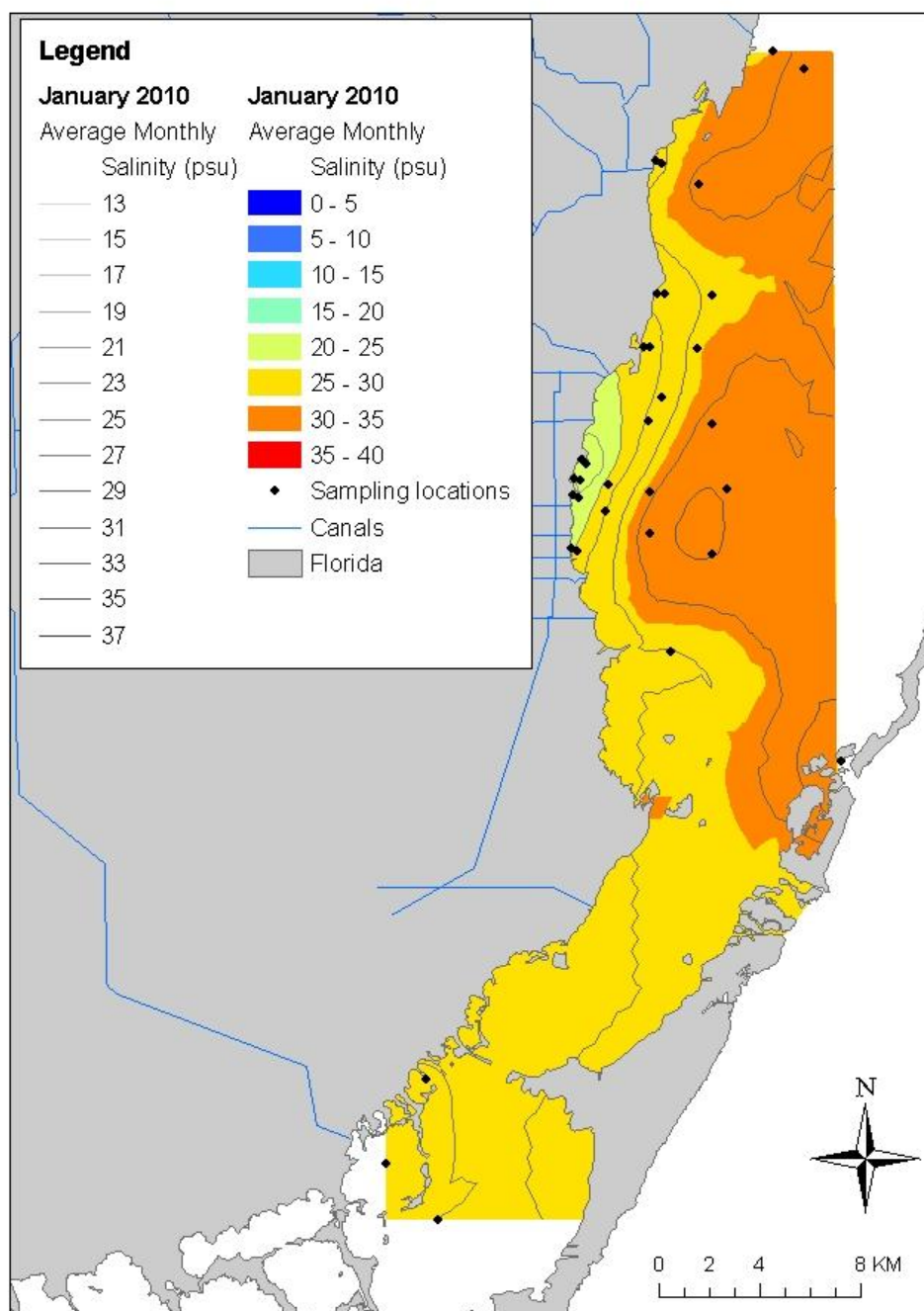
Appendix III – Figures



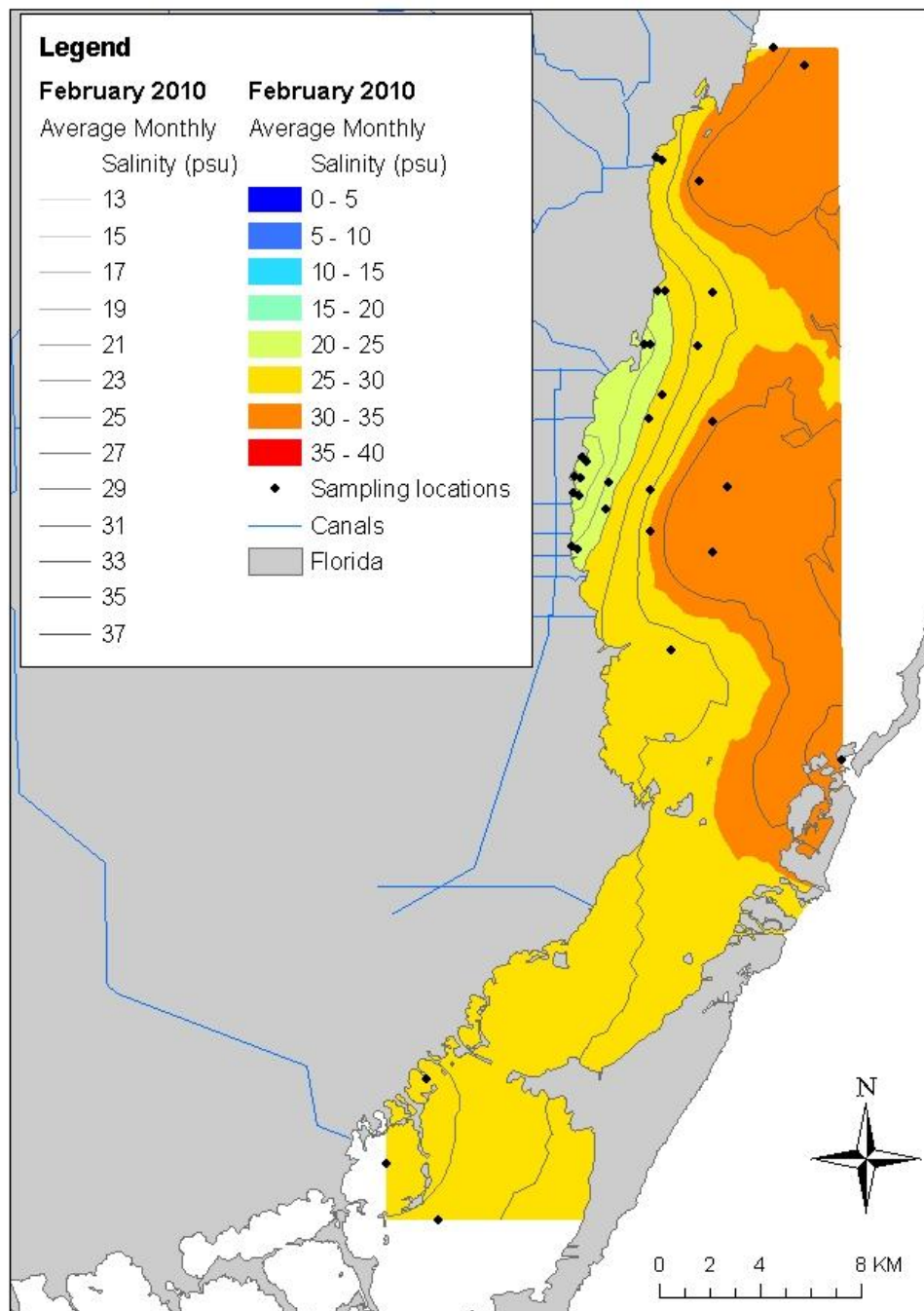
Appendix IV, Figure 3.2-1. Interpolated average salinity in Biscayne Bay for November 2009. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



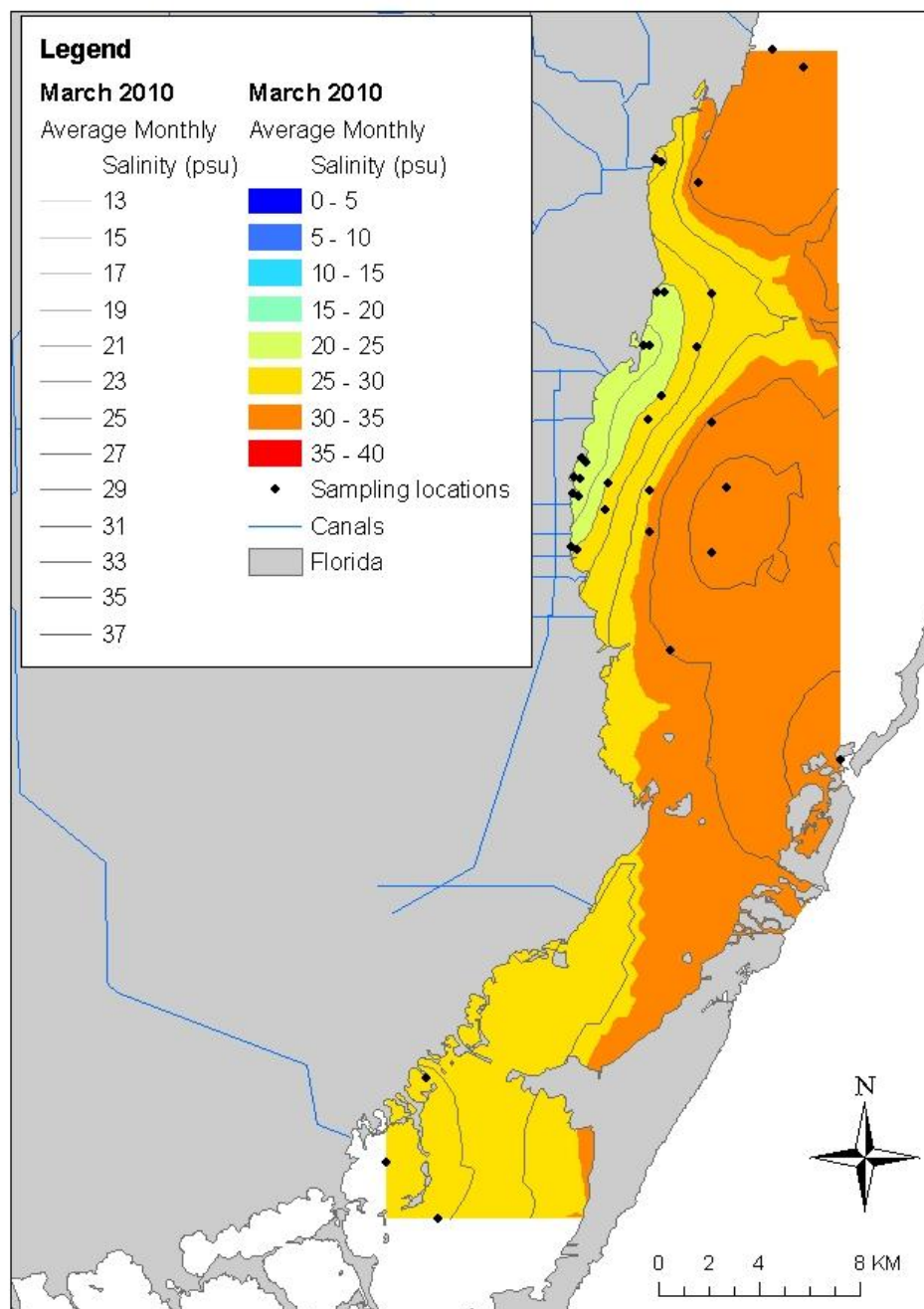
Appendix IV, Figure 3.2-2. Interpolated average salinity in Biscayne Bay for December 2009. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



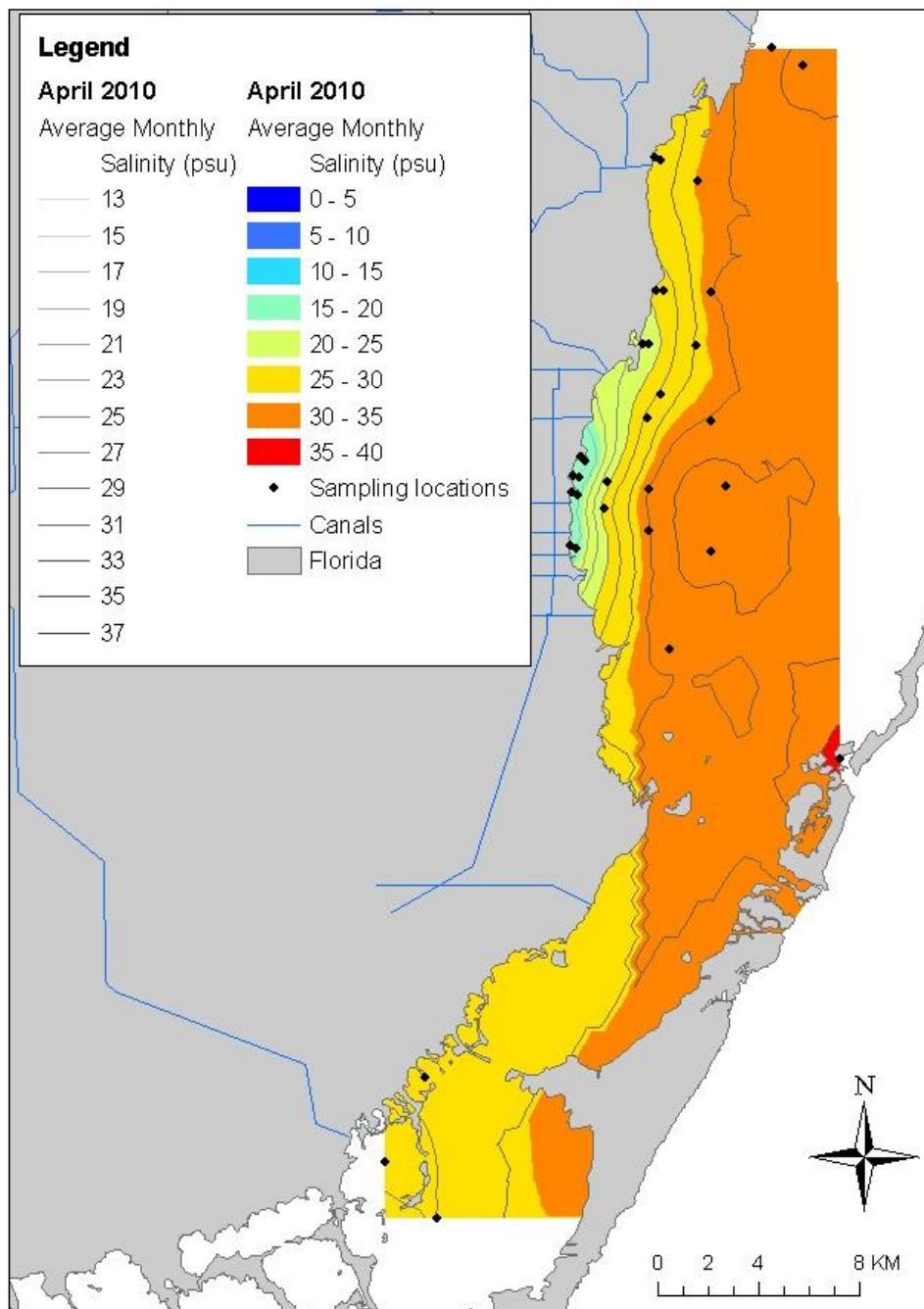
Appendix IV, Figure 3.2-3. Interpolated average salinity in Biscayne Bay for January 2010. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



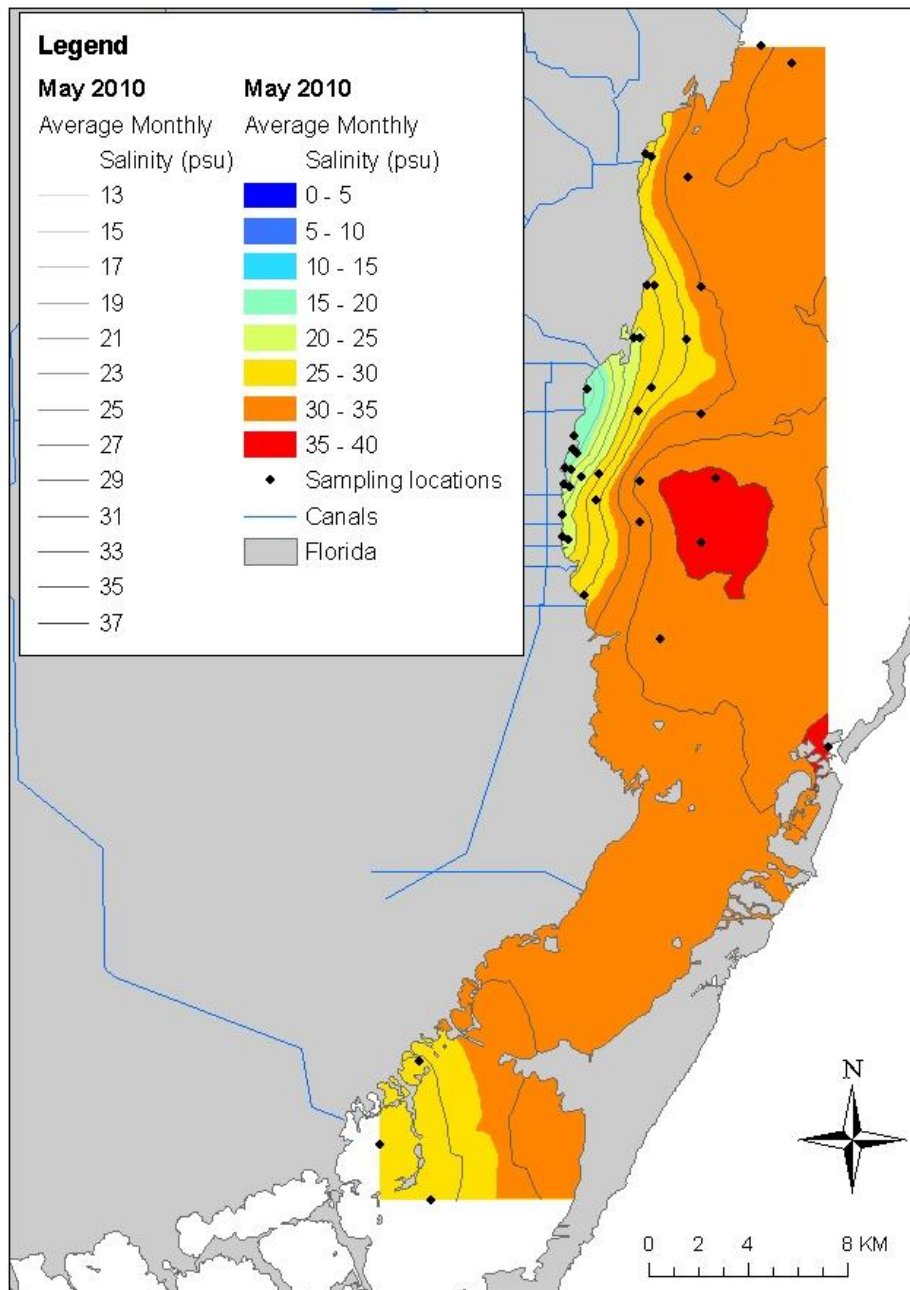
Appendix IV, Figure 3.2-4. Interpolated average salinity in Biscayne Bay for February 2010. Data from 32 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



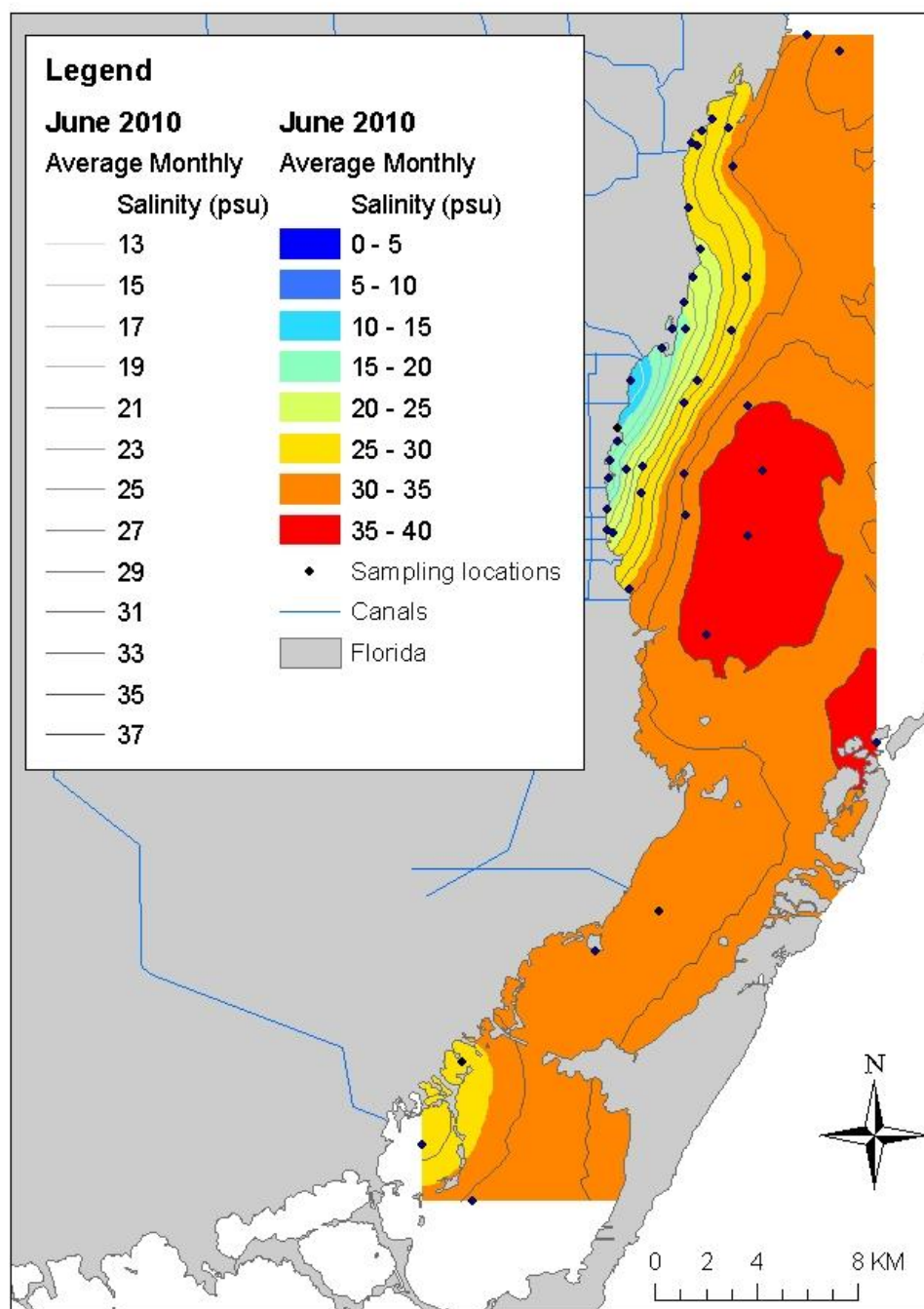
Appendix IV, Figure 3.2-5. Interpolated average salinity in Biscayne Bay for March 2010. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



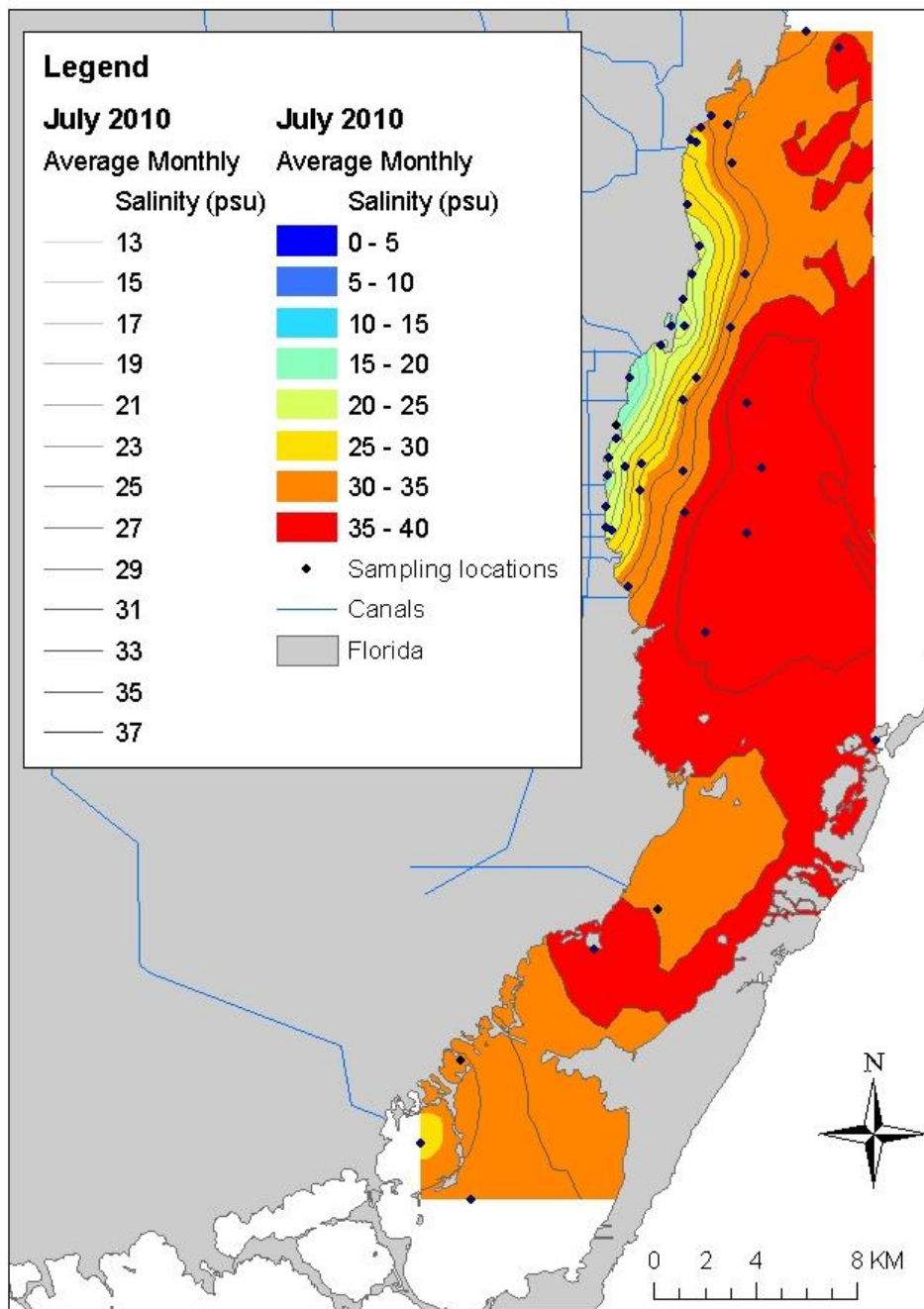
Appendix IV, Figure 3.2-6. Interpolated average salinity in Biscayne Bay for April 2010. Data from 32 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



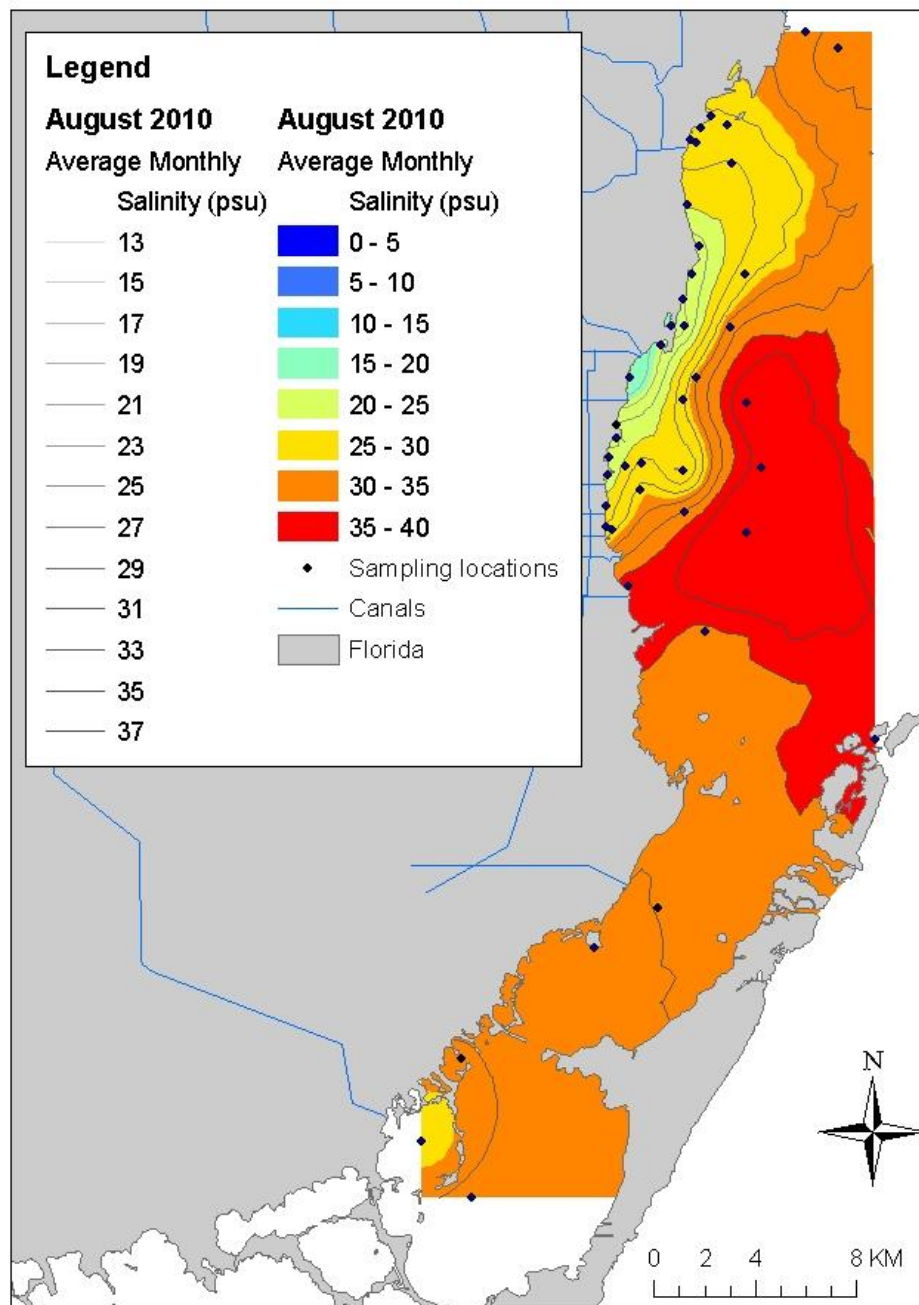
Appendix IV, Figure 3.2-7. Interpolated average salinity in Biscayne Bay for May 2010. Data from 32 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



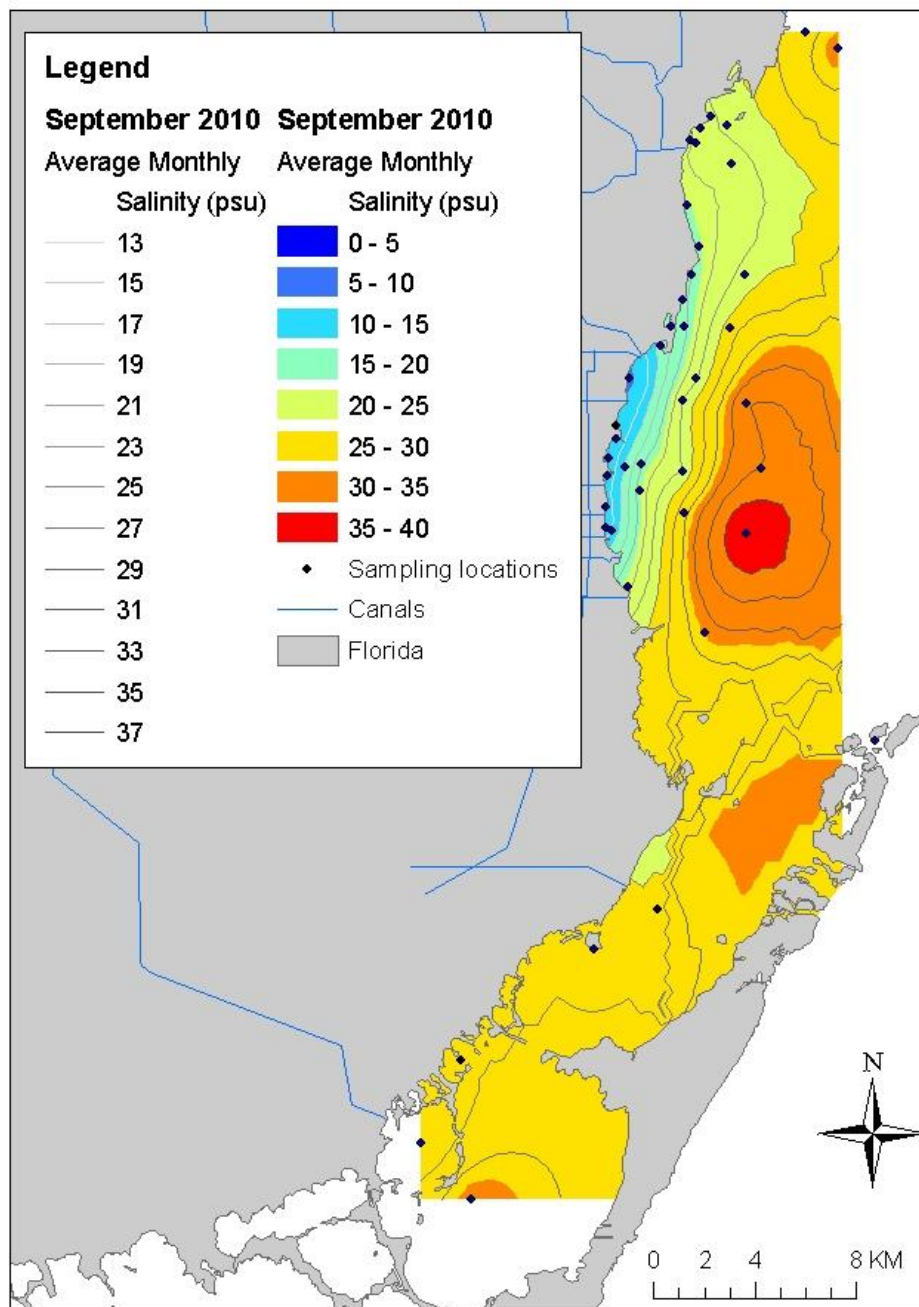
Appendix IV, Figure 3.2-8. Interpolated average salinity in Biscayne Bay for June 2010. Data from 36 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



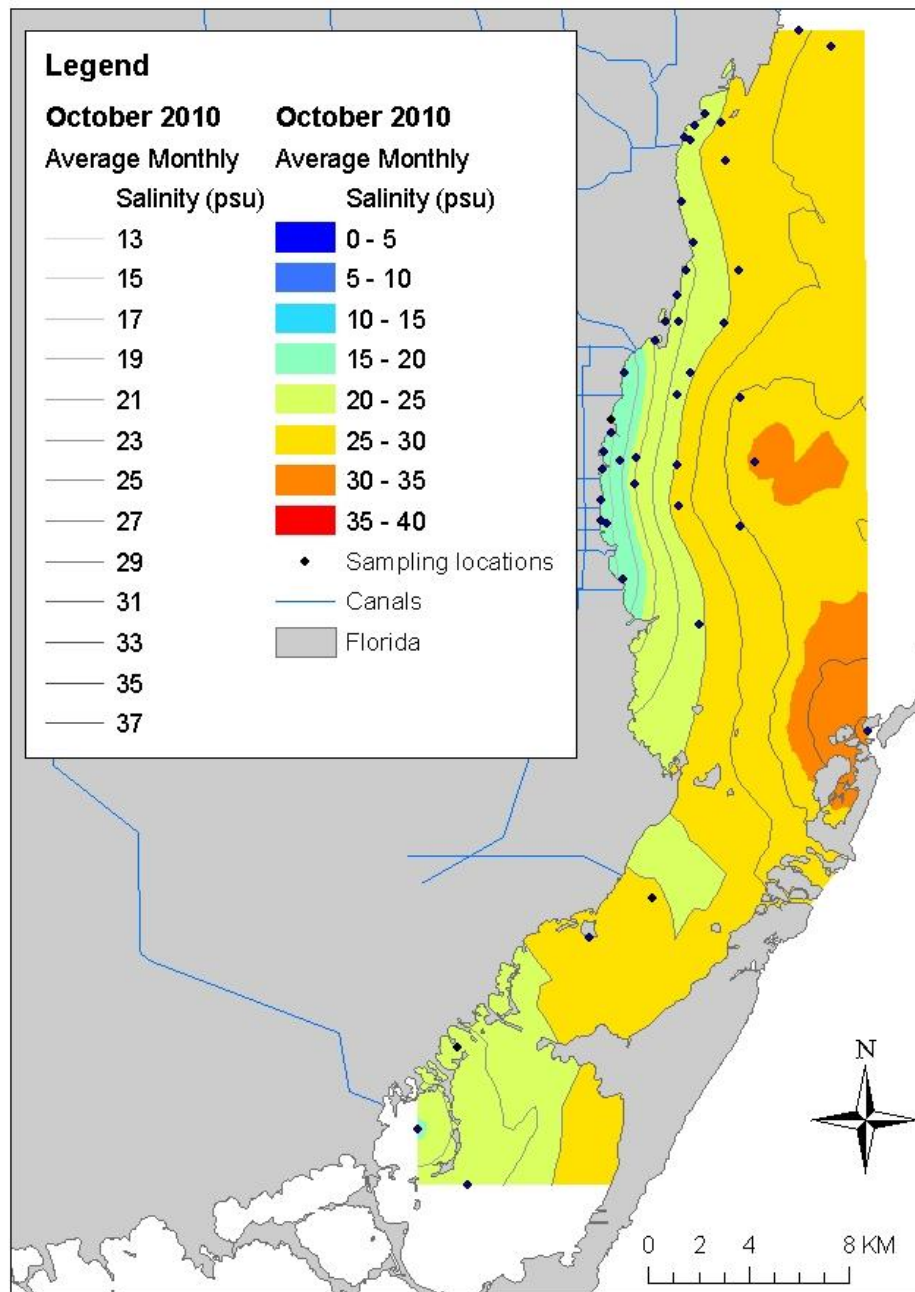
Appendix IV, Figure 3.2-9. Interpolated average salinity in Biscayne Bay for July 2010. Data from 38 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



Appendix IV, Figure 3.2-10. Interpolated average salinity in Biscayne Bay for August 2010. Data from 38 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



Appendix IV, Figure 3.2-11. Interpolated average salinity in Biscayne Bay for September 2010. Data from 36 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



Appendix IV, Figure 3.2-12. Interpolated average salinity in Biscayne Bay for October 2010. Data from 40 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.

Appendix IV- Estuarine Zones

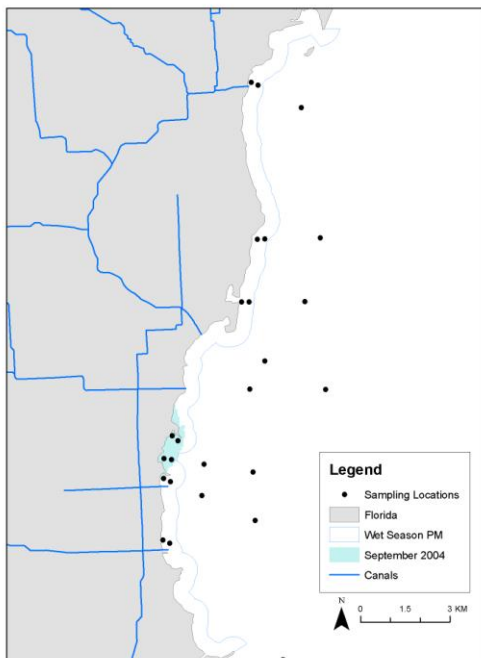


Figure 4.1-1. Estuarine zone (blue area: <20 psu) in September 2004.

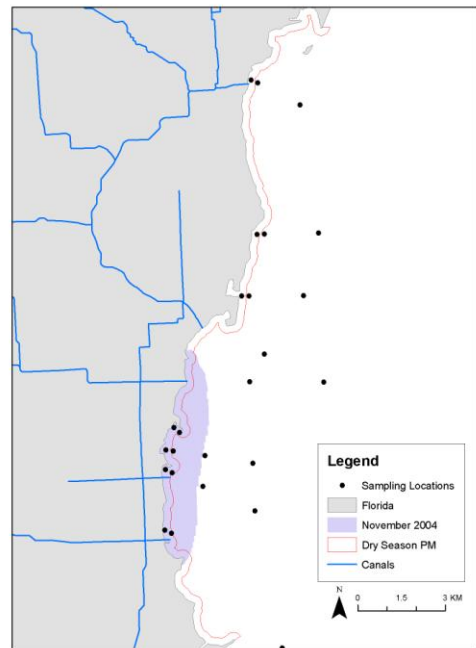


Figure 4.1-3. Estuarine zone (purple area: <20 psu) in November 2004.

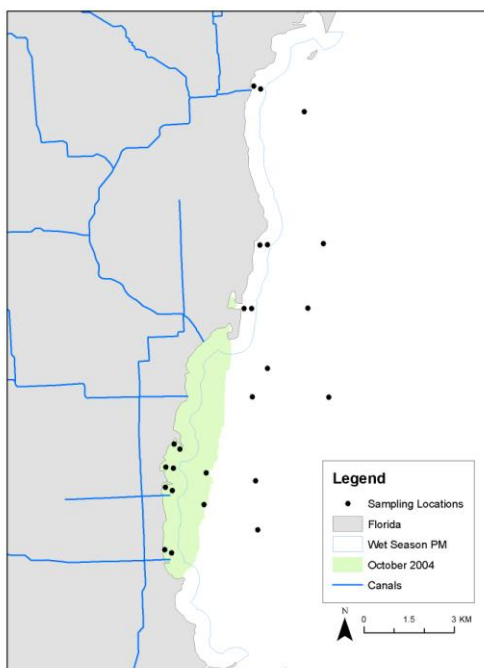


Figure 4.1-2. Estuarine zone (green area: <20 psu) in October 2004.

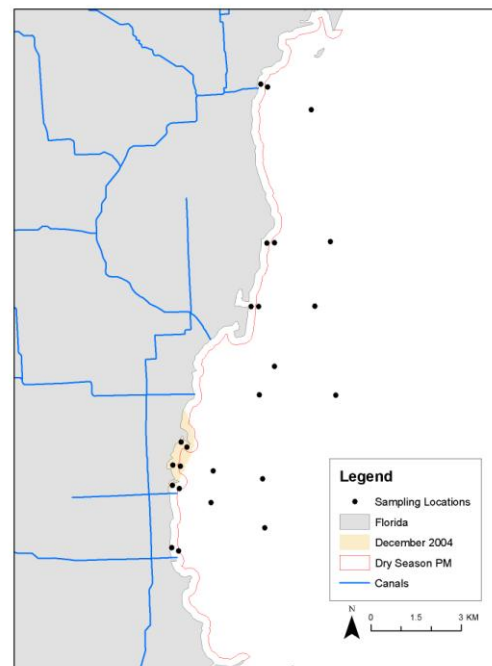


Figure 4.1-4. Estuarine zone (orange area: <20 psu) in December 2004.

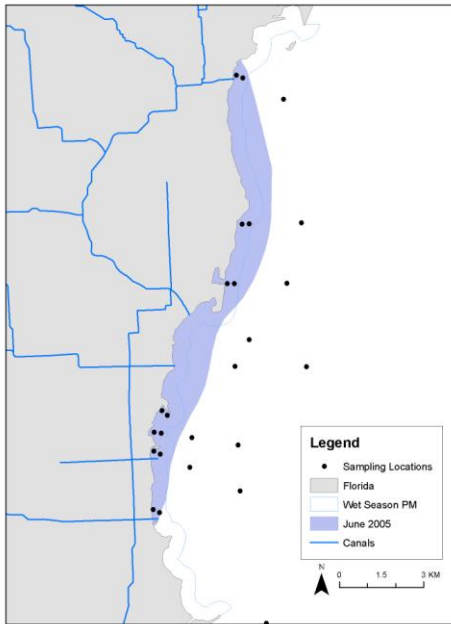


Figure 4.1-5. Estuarine zone (purple area: <20 psu) in June 2005.

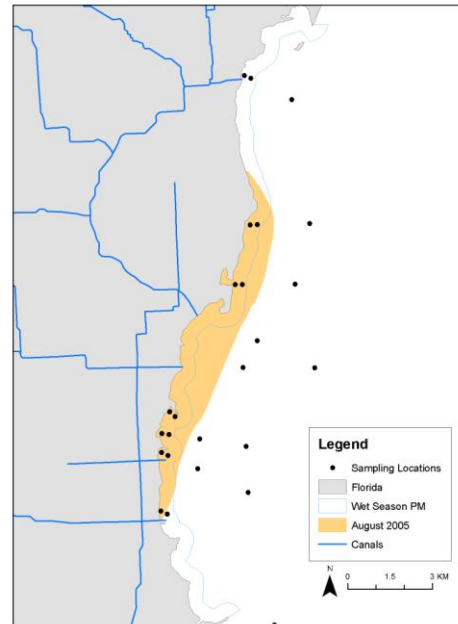


Figure 4.1-7. Estuarine zone (orange area: <20 psu) in August 2005.

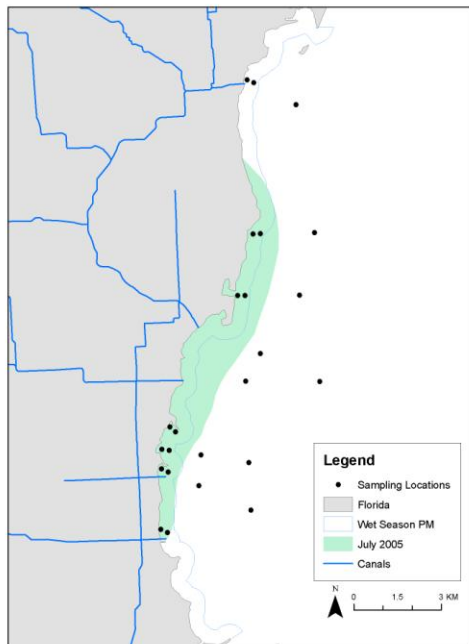


Figure 4.1-6. Estuarine zone (green area: <20 psu) in July 2005.

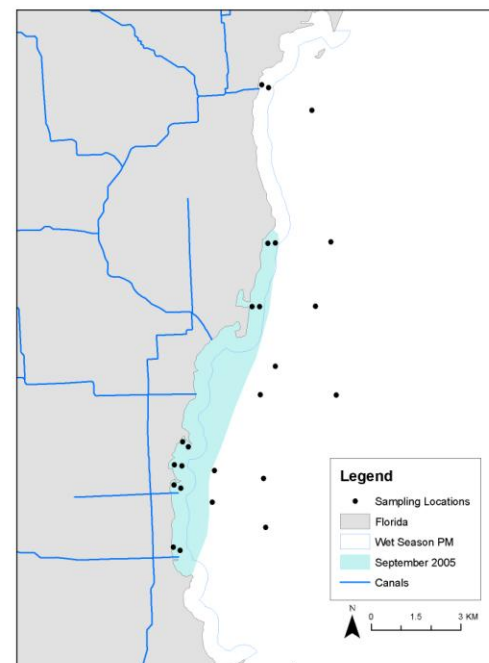


Figure 4.1-8. Estuarine zone (blue area: <20 psu) in September 2005.

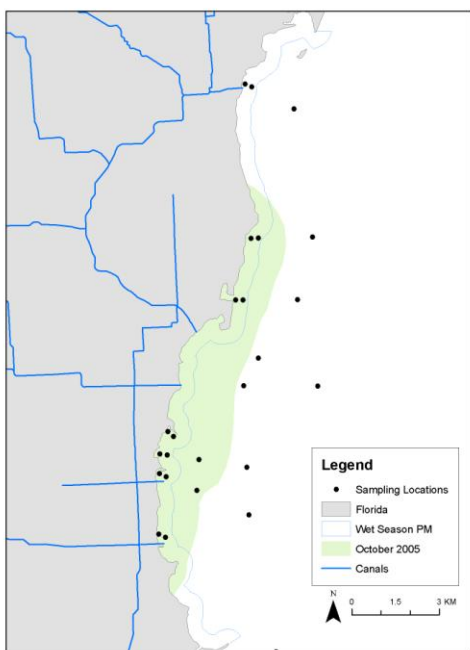


Figure 4.1-9. Estuarine zone (green area: <20 psu) in October 2005.

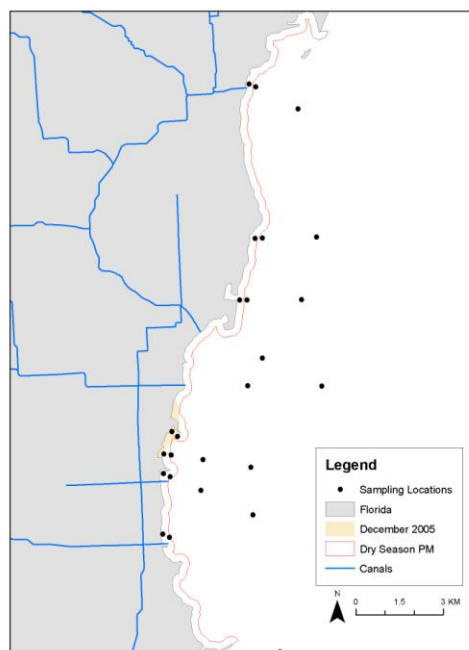


Figure 4.1-11. Estuarine zone (orange area: <20 psu) in December 2005.

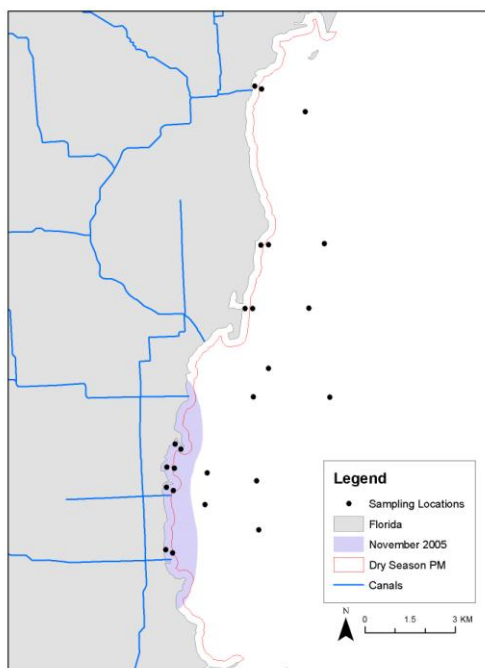


Figure 4.1-10. Estuarine zone (purple area: <20 psu) in November 2005.

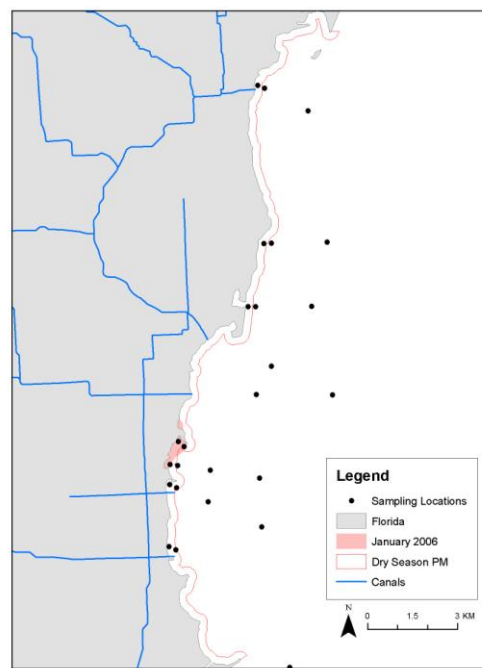


Figure 4.1-12. Estuarine zone (pink area: <20 psu) in January 2006.

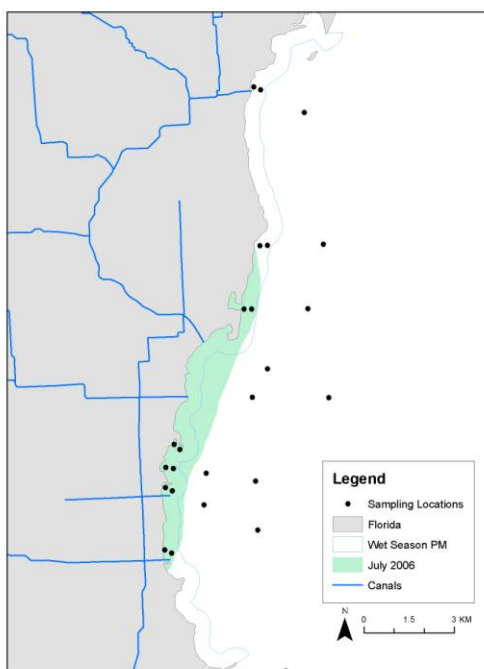


Figure 4.1-13. Estuarine zone (blue area: <20 psu) in July 2006.

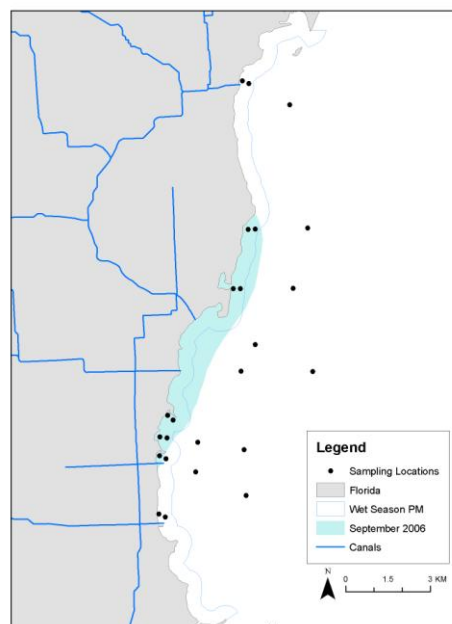


Figure 4.1-15. Estuarine zone (blue area: <20 psu) in September 2006

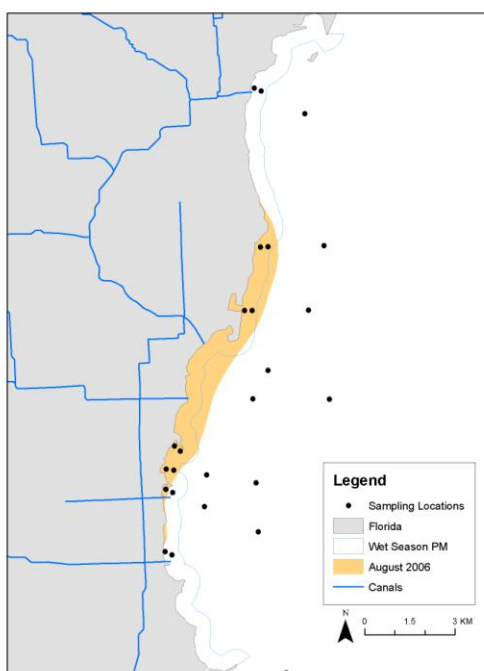


Figure 4.1-14. Estuarine zone (orange area: <20 psu) in August 2006.

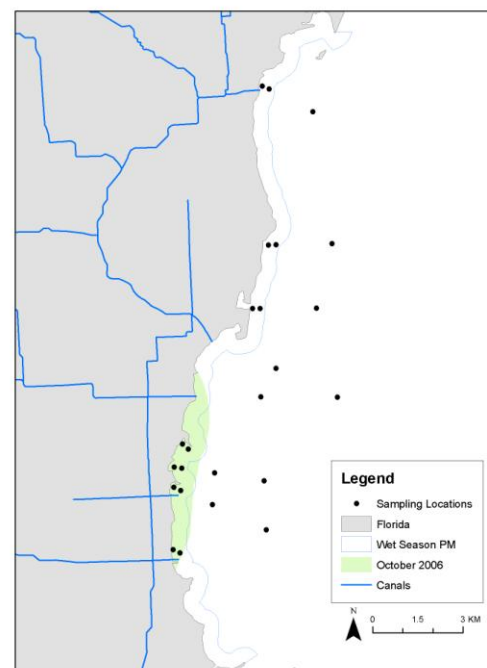


Figure 4.1-16. Estuarine zone (green area: <20 psu) in October 2006.

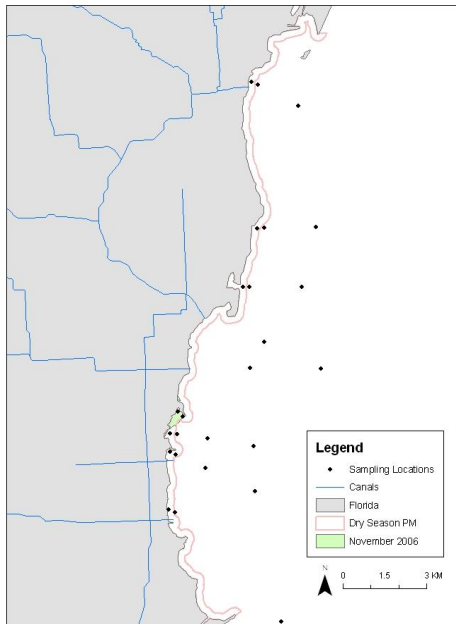


Figure 4.1-17. Estuarine Zone (green area: <20 psu) in November 2006.

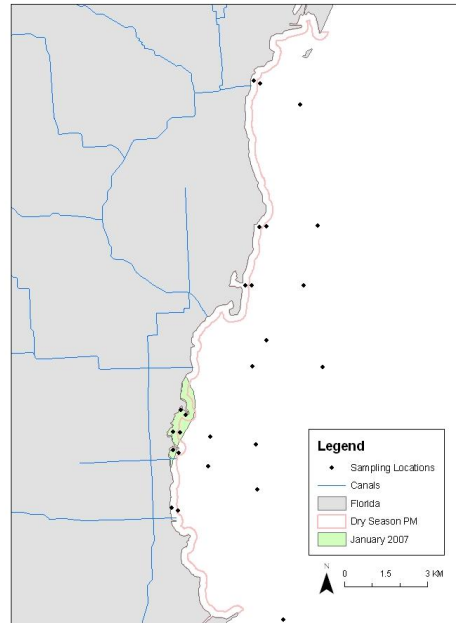


Figure 4.1-19. Estuarine Zone (green area: <20 psu) in January 2007.

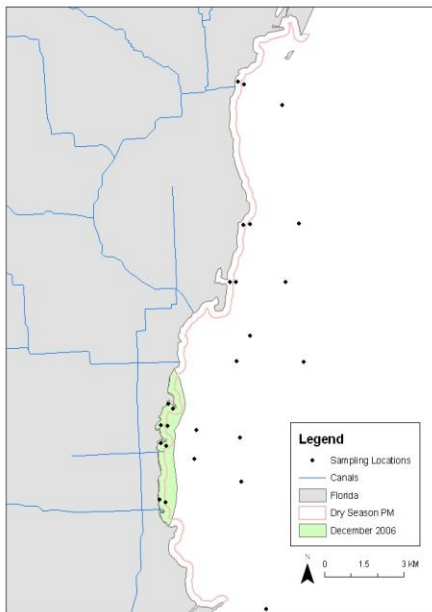


Figure 4.1-18. Estuarine Zone (green area: <20 psu) in December 2006.

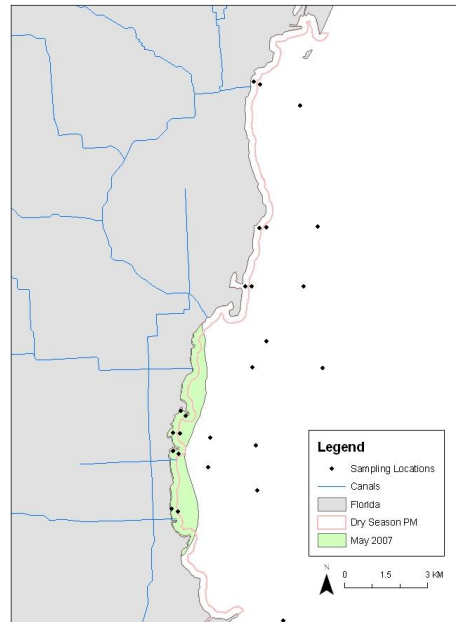


Figure 4.1-20. Estuarine Zone (green area: <20 psu) in June 2007.

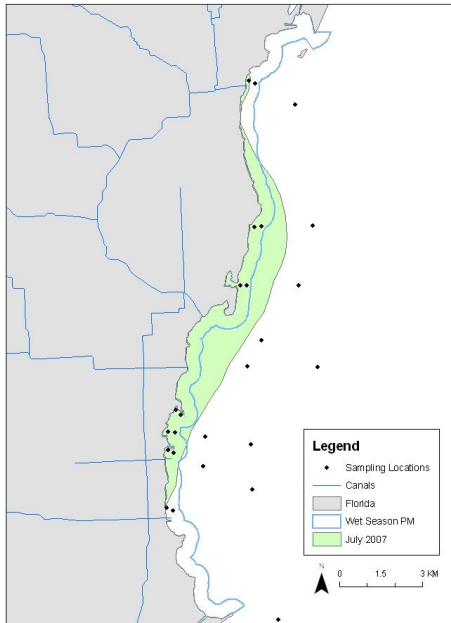


Figure 4.1-21. Estuarine Zone (green area: <20 psu) in July 2007.

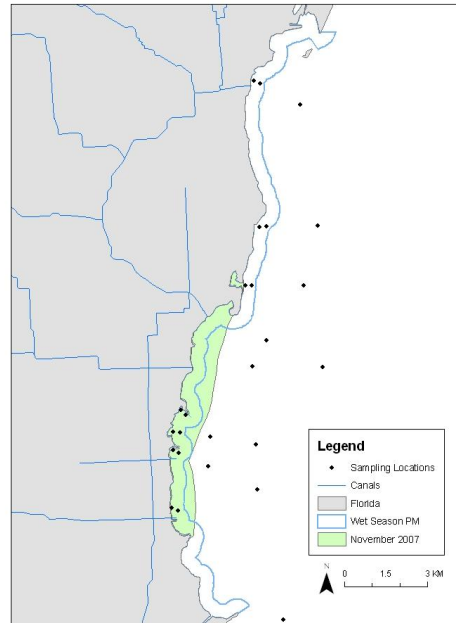


Figure 4.1-23. Estuarine Zone (green area: <20 psu) in November 2007.

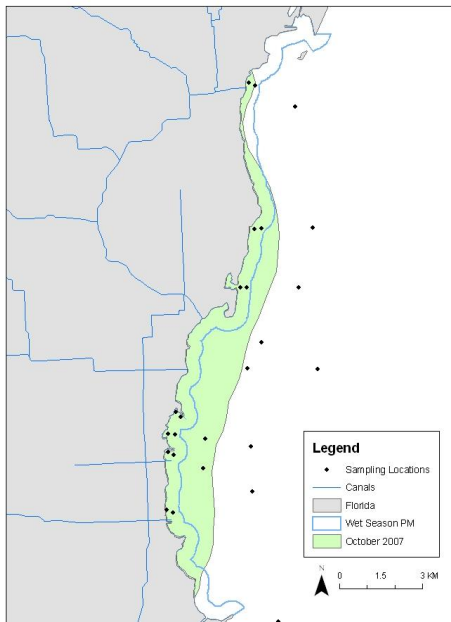


Figure 4.1-22. Estuarine Zone (green area: <20 psu) in October 2007.

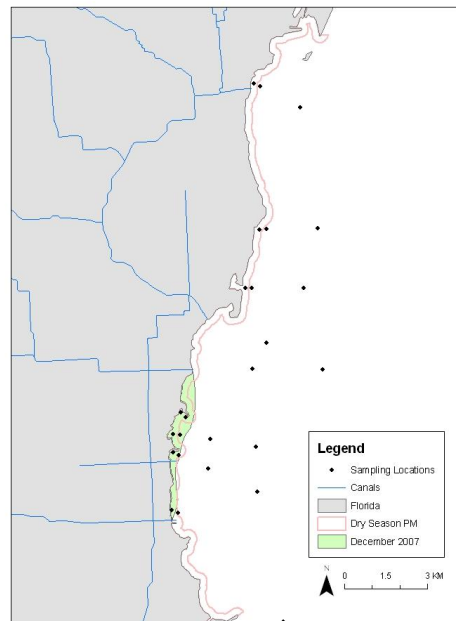


Figure 4.1-24. Estuarine Zone (green area: <20 psu) in December 2007

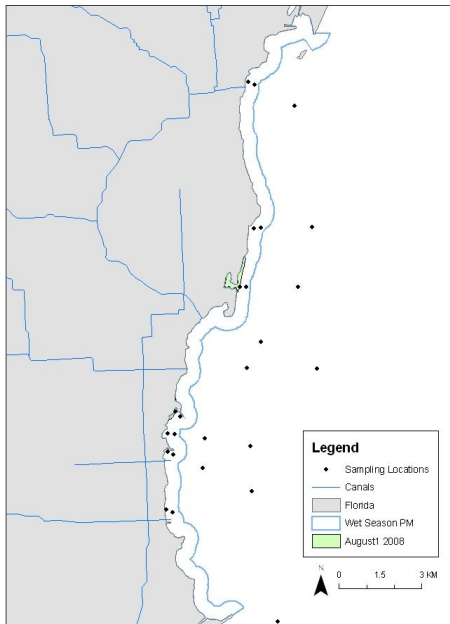


Figure 4.1-25. Estuarine Zone (green area: <20 psu) in August 2008.

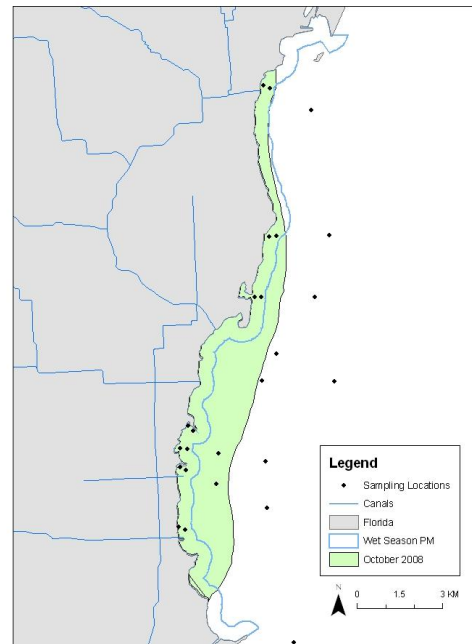


Figure 4.1-27. Estuarine Zone (green area: <20 psu) in October 2008.

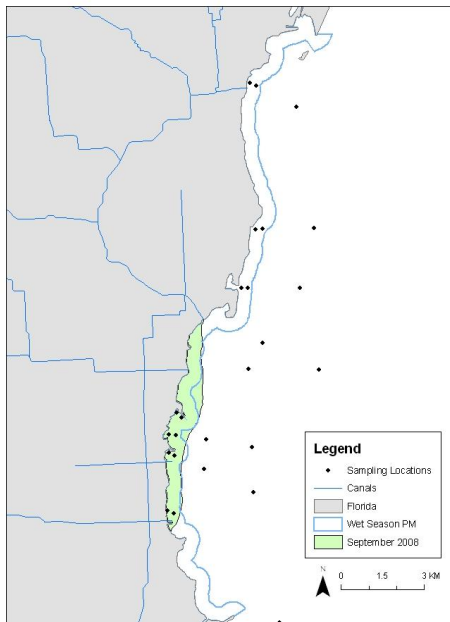


Figure 4.1-26. Estuarine Zone (green area: <20 psu) in September 2008.

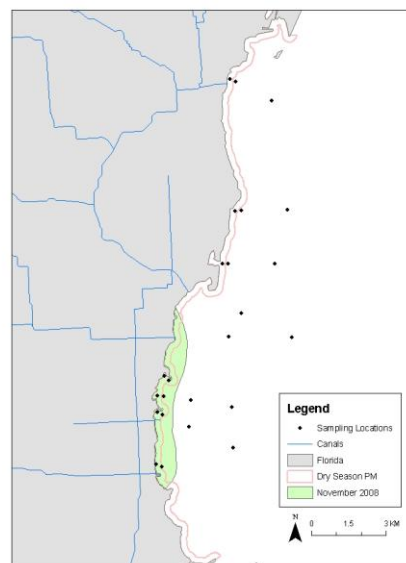


Figure 4.1-28: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in November 2008.

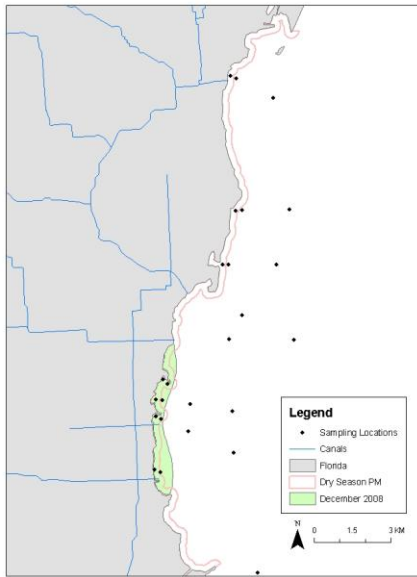


Figure 4.1-29: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in December 2008.

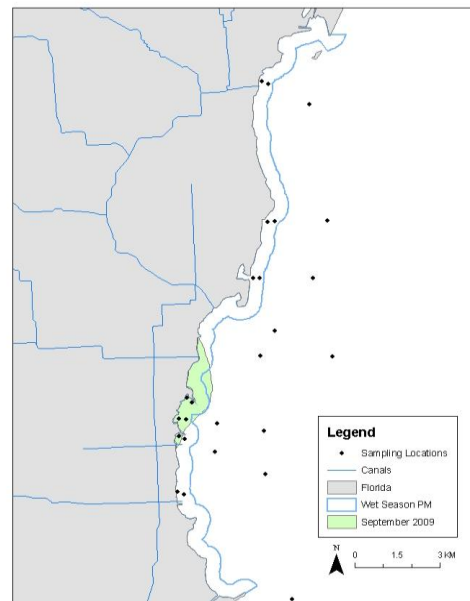


Figure 4.1-31: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in September 2009.

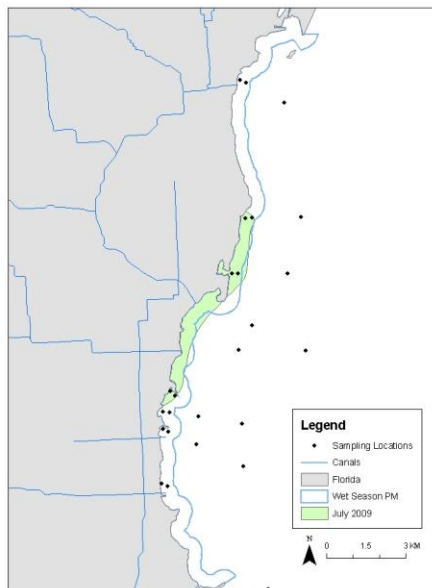


Figure 4.1-30: Estuarine Zone area meeting CERP-PM (green area: <20 psu) in July 2009

Appendix V – Implementation Plan

Implementation Plan

Biscayne Bay Salinity Sampling Project for the Monitoring and Assessment Plan Implementation Plan 2010-2014

(December 2010)

**Biscayne Bay Salinity Sampling Project for the Monitoring and Assessment Plan
Implementation Plan
2010-2014**

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1.0 Background

Biscayne Bay is the largest estuary on the southeast coast of the Florida peninsula (Figure 1). Biscayne Bay extends from Broward County to the north, through Miami-Dade County and part of Monroe County to the south, where the Bay is marginally connected to Florida Bay (through Jewfish Creek), west of Barnes Sound.

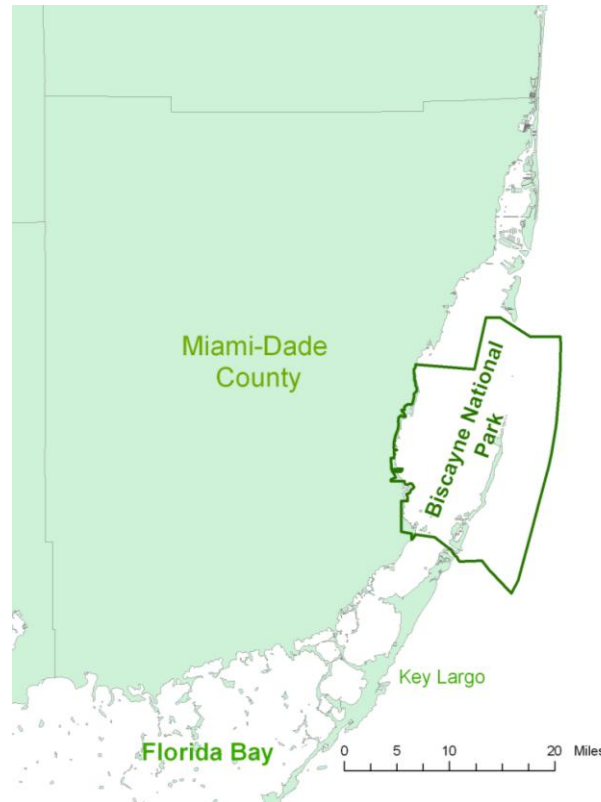


Figure 1: Location map of Biscayne Bay.

Physical processes that can have an impact on the water quality within the system vary both spatially and temporally. Monitoring the salinity conditions and several other water quality parameters of Biscayne Bay is important for documenting the CERP implementation effects in the southern estuarine ecosystem environment.

2.0 Specific Objectives to be Addressed

The purpose of this work is to collect physical water quality data (salinity, conductivity, temperature and depth) at all existing stations to allow decisions and inferences to be made with respect to changes in freshwater inflow. This provides data to other scientists and managers using the broadest manner. This study establishes reference conditions (document temporal and spatial variability of salinity in the near shore region of Biscayne Bay).

3.0 Approach and Methods

3.1 Data Collection and Instruments Calibration

3.1.1 Instrument Location and Deployment

There are 44 sites where data is collected within central and southern Biscayne Bay (Figure 2). Three of the 44 sites within the bay are recording data at approximately 0.25 meters below the water surface via meters placed within a surface buoy. Sites are located as far north as the southern side of the Snapper Creek Canal and extending south to Manatee bay and Barnes Sound. The sampling sites are set up as a series of east-west transects that radiate outward from canals or other interesting hydrological features. These transects are meant to document a progression of estuarine conditions from near shore to marine conditions offshore. There are twenty sites in the mangrove zone, which are expected to be the first area affected by changes in freshwater delivery to the bay. Twenty four sites are located in the central area of the bay. Sites were also chosen as special interest areas, such as Black Point and Turkey Point, and Barnes Sound and Manatee Bay because of their hydrology and proximity to key environmental concerns and changes in water flow.

The multi-probe instruments used for the collection of data are YSI Environmental 6600 Series. Surface measurements are taken 0.25 meters below the water surface where meters are placed within a specially designed navigational surface buoy. The instruments are also deployed at sites within the bay, on the bay floor. The sites with navigational surface buoys have bottom meters deployed horizontally to reduce interaction with the attachment chain of the buoy. Only three bottom sites are still deployed vertically (Figure 3). The distance from the bottom is measured at each site. At those sites where there is horizontal deployment, the meter will be locked onto a concrete paver fitted with two eyebolts. At one end, the smaller eyebolt has two UV-black cable ties. The meter is inserted through one cable tie of the eyebolt to hold the meter in the correct position. The other eyebolt at the far end of the paver is used to lock the instrument down with a brass padlock. The end of the meter with the u-bolt is locked to the other eyebolt and secured at both eyebolts with a cable tie. During horizontal deployment, it is essential the sensor be facing sideways to prevent flow through the opening to the sensor from being blocked by biofouling organisms. At vertical deployment sites the U-bolt of the meter cage is attached to an eye-pin cemented into the bay floor using a brass padlock.

A cage is screwed onto the base of each meter to protect the sensors. Each cage is equipped with a U-bolt used to lock the meter to an I-pin. Tags are placed on the handle of each meter citing its intended site of deployment for ease of identification once in the field. Those meters that are deployed vertically have a small crab pot buoy attached to the top end of the meter so that it stays upright in the water column.

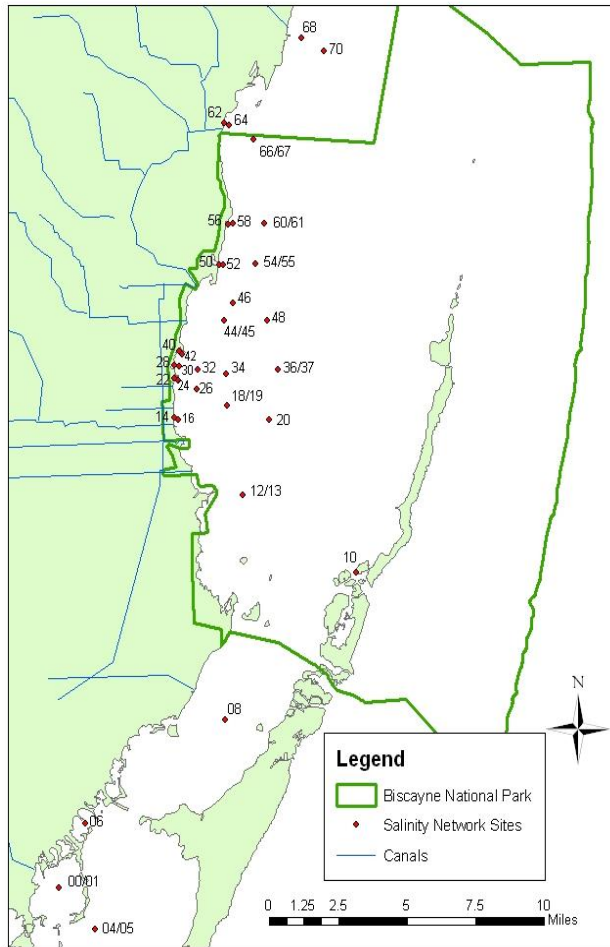


Figure 2: Map showing all the sites in project.

3.1.2 Data collection and Retrieval

YSI 6600 Data Sondes collect continuous conductivity, temperature and depth. These instruments are deployed on a three week rotation schedule. Data is collected in 15 minute intervals. Instruments are overlapped for greater than 4 readings during retrieval/deployment. The retrieved instruments are brought back to the lab for data upload to NPS computers, post calibration, cleaning and calibration.

3.1.3 Calibration

The sensor is placed in the same calibration standard used to calibrate the instrument. Temperature, specific conductivity, depth, and battery voltage are recorded onto the calibration sheet, which are later entered into the computer and associated with that particular filename and



Figure 3: Vertical Deployment of instrument

site. (Figure 4). Cell constants are also reviewed and recorded to make sure they fall within the range of acceptability (5.0 +/- 0.5). Sondes are calibrated with the 50 mS/cm standard as a single point. Post calibration is done twice: once prior to the meter being cleaned of biofouling and then once after the meter has been cleaned. The meter is then recalibrated and if necessary, set up to record for the next set of sites. Once calibrated, the instrument is set up in unattended mode with the file name corresponding to site number, instrument number, and date of deployment.

CALIBRATION DATA SHEET					
Date (mm/dd/yy) _____		Station Number _____			
Instrument Type _____		Sonde ID Number _____			
Lab Tech _____		Date Deployed _____		Set up by: _____	
Calibration Information		Calibration Results		Post-Calibration Results	
Conductivity				PreClean Clean	
Calibration Standard Value _____				mS/cm	
Carbouy Number _____					
Sensor Reading _____				mS/cm	
Zero Check _____				mS/cm	
Cell Constant _____					
Temperature ° Celsius _____					
Depth/Pressure _____					
Battery Voltage _____					
Notes: _____					

Sample Rate _____ MIN					
Delay Sample time _____ (EST)					
Atmospheric Pressure _____		DATE RECOVERED _____			
Initial value	Ending value	Difference	DATA FILE NAME _____		
Processing Information To Be Filled in By ERDC					
Sensor Offsets: _____		Pressure _____	Salinity _____	Temperature _____	
Atmospheric Offset _____					
(ERDC)					

Figure 4: Calibration data sheet.

a) Temperature

The temperature probe is checked during calibration using a laboratory traceable NIST Celsius thermometer. A temperature reading must be within +/- 0.15 degrees Celsius to be acceptable. If the check does not meet these requirements, the sonde will be checked. If the sonde

still does not prove correct, the associated data will be flagged and the unit will then be sent to the manufacturer for service. The temperature probe is also checked by the factory during maintenance and service of the instrument.

b) Conductivity

The conductivity probe is calibrated by filling the calibration cup with a conductivity standard and is adjusted to that value. Calibration procedures are based on and follow the manufacture YSI recommendations. The calibration is accepted if the sonde reads within $\pm 0.5\%$ of the true value of the standard. If the reading does not meet these limits, the problem will be determined and corrected. Conductivity is calibrated using one point. The YSI 6600 meets or exceeds advertised conductivity specifications with a single point calibration. However, a zero check is done with deionized water to ensure accurate calibration and is noted on the Calibration Sheet. In the event the zero check does not read zero, the meter is recalibrated.

c) Depth

Depth is determined using a pressure sensor. Barometric pressure, taken from a Princo Nova mercury barometer located in the laboratory is recorded on the calibration sheet and the depth is calibrated to 0 meters. Atmospheric pressure is noted to ensure the meters are responding throughout the expected measurement range. If an incorrect reading is observed, the sensor will be cleaned and rechecked. If the problem is not corrected by cleaning, the manufacturer is contacted for instructions/recommendations.

d) Weather Data

A portable weather instrument (Kestrel Pocket Weather Tracker) is used to record deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Wind direction, wave height and the meter identification number are also recorded onto field data sheets at each deployment site (Figure 5). All the data collected at deployment sites is entered into a database along with information about the calibration of each instrument used at every site. Time on the weather instrument is standardized to Eastern Standard Time at the beginning of each deployment trip with the atomic clock in Boulder Colorado. Once all meters are deployed within the zone, there is a waiting period of a minimum of one-hour before retrieving the old meter. The waiting period allows a minimum of four-consecutive overlap readings. The meters to be retrieved are then collected, with all relevant environmental data collected as well.

e) Calibration Standards

The conductivity standard is purchased from YSI. The YSI conductivity standard, the 50 mS/cm standard, is traceable to the National Institute of Standards and Technology (NIST). As manufactured, it met or exceeded its current specifications (YSI Certificate of Traceability). The rinse water used in calibration procedures is de-ionized water obtained from a Millipore Direct-Q Water Filtration System with a conductivity of 0.0 mS/cm. After calibration, de-ionized water is

used to perform a zero-check. If the readings are not zero when the instrument is placed in the de-ionized water, the meter is recalibrated. The instruments are then prepared for deployment.

RETRIEVAL AND DEPLOYMENT OF BISCAYNE BAY YSI INSTRUMENTS			
Date: _____		Field Techs: _____	
Station #: _____		Instrument Type: _____ (6000 or 6600)	
Instrument ID: _____	Deployed: _____ (EST)	Filename: _____	Date: _____
Instrument ID: _____	Retrieved: _____ (EST)	Filename: _____	Date: _____
<u>Conditions at Deployment:</u>		<u>Conditions upon Retrieval:</u>	
Air Temp (C): _____	Barometric Pressure (in. Hg): _____	Air Temp (C): _____	Barometric Pressure: _____
Est. Wave Height (ft): _____	Wind Direction: _____	Est. Wave Height (ft): _____	Wind Direction: _____
Wind Speed (k): _____		Wind Speed (k): _____	
NOTES: _____			
RETRIEVAL AND DEPLOYMENT OF BISCAYNE BAY YSI INSTRUMENTS			
Date: _____		Field Techs: _____	
Station #: _____		Instrument Type: _____ (6000 or 6600)	
Instrument ID: _____	Deployed: _____ (EST)	Filename: _____	Date: _____
Instrument ID: _____	Retrieved: _____ (EST)	Filename: _____	Date: _____
<u>Conditions at Deployment:</u>		<u>Conditions upon Retrieval:</u>	
Air Temp (C): _____	Barometric Pressure (in. Hg): _____	Air Temp (C): _____	Barometric Pressure: _____
Est. Wave Height (ft): _____	Wind Direction: _____	Est. Wave Height (ft): _____	Wind Direction: _____
Wind Speed (k): _____		Wind Speed (k): _____	
NOTES: _____			

Figure 5: Retrieval and Deployment Data Sheet

3.2 Field and Laboratory Quality Control Checks

Quality control procedures are those steps taken by laboratory and field staff to insure accuracy in data collection and reliability of the data itself.

3.2.1 Field Quality Control Checks

Quality control checks performed in the field are the following:

1. Field sheets are used to record which sonde is being deployed and which sonde is being retrieved. Each sonde has a unique identification number displayed on the exterior in black marker corresponding to a unique YSI serial number. These sheets are then placed in the field logbook. The format used for this data sheet is shown in Figure 5.
2. Field technicians are to verbally confirm sonde identification upon deployment and retrieval to another field technician in the boat who records this on a field sheet. A tape indicating the date of calibration and site of deployment is also attached to each instrument handle bail.
3. Sondes are dual deployed for a minimum of four readings or 1 hour in order to have simultaneous data (four concurrent samples) recorded at each site. For each deployment before leaving the lab, field technicians check the clock in the laboratory for the correct time. Time is determined by the atomic clock in Boulder Colorado. Time is checked for the laboratory clock before each calibration and this value is then used in setting up the sondes for field deployment. This allows absolute knowledge of when the sonde is reading in the field and is used to determine the overlap period.
4. At horizontal deployments, the field technician must place the data sonde so that the conductivity probe is positioned on its side, not directly up or down. This prevents sediment from entering the probe and also keeps air bubbles from getting trapped in the probe. In vertical deployment buoys are attached to the bail to hold the instrument vertical (Figure 3). Both methods of deployment have the instruments locked to the bottom with brass or stainless steel padlocks and held in place with plastic zip ties. Both methods of deployment allow the instrument to record at the same depth.

3.2.2 Laboratory Quality Control Checks

The lab technician will be responsible for checking field log for discrepancies in deployment or retrieval procedures upon downloading the data. It is also necessary to monitor individual instrument response documented in the calibration and/or maintenance logbook should such problems arise.

The procedures for post calibration check are the same as the calibration procedures shown in Figure 6. Post calibration procedures will be performed after data is downloaded. Any variance is recorded on original calibration sheet to show possible drift in the collected data. If a problem is found during post calibration and cannot be resolved by the lab technician, the instrument will be removed from use and serviced. This will be documented in the maintenance log.

After calibration, a tape indicating the date of calibration is attached to the instrument handle and units are prepared for deployment. At this time the lab technician places the appropriate size protective cage over the probes.

Calibration Checklist for 6- Series CTDs	
	SPECIFIC CONDUCTIVITY
	Dry sensor with cloth
	Collect two samples of calibrated seawater, noting the carbuoy #
	Rinse the sensor head with the first sample of calibrated seawater by dipping the probes into the rinse multiple times
	Use a ring stand and clamp to secure the conductivity probe in the second calibration standard sample, making sure the waterline is at the appropriate height.
	In Ecowatch, select 2 – Calibration , then 1— Conductivity , then 1 – Specific Conductivity
	Input the specific conductivity of the standard.
	Allow temperature to equilibrate before calibration
	DEPTH
	Record barometric pressure
	In Ecowatch, select 2 – Calibration , then 2 – Pressure/Abs
	Input 0.0
	Allow depth to equilibrate before calibration
	After calibration, rinse with de-ionized water and store for deployment
	INSTRUMENT DEPLOYMENT
	If sonde unit passes all checks, assign it to the next deployment station to replace an instrument of similar type
	Use Ecowatch to open menu screen for unattended sampling
	Select 4 – Status and select Date and Time . Check time against atomic clock. Update if necessary.
	Select 1 – Interval and enter 00:15:00 (15 minutes)
	Select 2 – Start Date to set the date that data will begin to log to sonde memory
	Select 3 – Start Time to set the time that data will begin to log to sonde memory
	Select 4 – Duration days = 365
	Select 5 – File and enter the file name using the following data file format: LLNNMDDY (Where LLNN is the station identifier – Site Location and YSI Instrument Number)
	Select 6 – Site and enter site number
	Select 7 – Battery to make sure that the voltage is suitable for the length of the study
	Make sure you select C – Start Logging to accept your entries and start sonde!

Figure 6: Example of Calibration Checklist for YSI 6600 instruments.

3.3 Data Entry, Evaluation and Validation

Several protocols have been applied to the datasets in order to improve accuracy and eliminate the potential for errors. Most of these changes are related to how the data is managed and altered after downloading. The aim of organizing the data is to create a complete dataset that spans a complete calendar year.

3.3.1 Data Entry and Transfer

Using YSI Endeco-EcoWatch software, the data is downloaded to the computer as a text file. This allows the data to be ready to be uploaded directly on the Everglades National Park DataForEver Database without any changes in the data. This avoids the potential of additional errors of manipulating data to adjust format and make data corrections outside of the database. Only the actual data from the deployment is uploaded to the database. The readings before the deployment and after retrieval are not uploaded into the database.

Since salinity is not a variable that can be directly measured, specific conductivity and temperature is used to calculate salinity in the Coach program. According to the YSI Ecowatch Manual, raw conductivity and temperature values are used with each value of specific conductance to generate a value compensated to 25°C. Using a temperature coefficient of 1.91%/C° (TC = 0.0191), the equation is as follows:

$$\text{Specific Conductance (25°C)} = (\text{Conductivity}/1 + \text{TC} * (\text{T}-25))$$

Once data is uploaded to the database, data is graphed inside the DataForEver Database to help identify errors. Each sampling event is graphed and there is a graph for each of the major variables including temperature, salinity, specific conductivity, and depth versus time. The graphs produced from this step are used later for data interpolation. In addition, the graphs allow for easy detection of data points recorded prior to actual deployment, that were not deleted in the first step. Any data errors and obvious data problems can then be seen in this step. Any errors including battery failure or incorrect depth reading indicate that the data must be viewed much more closely. This could be seen for example if a top instrument falls out of the buoy and onto the bay floor then the depth will dramatically increase and so this information can then be deleted in the data validation step.

Since the data are generally consistent, these errors can usually be seen and fixed easily. Any changes that are made to the data based on the graphs are made in the database allowing us to keep track of changes that are made to the raw data. In this database any malfunction of the probes is also noted even if the data cannot be fixed, in this case the data is removed from final approved dataset and null values inserted. All Raw data and changes made to it are maintained in the database along with the approved, validated data.

3.3.2 Data Evaluation and processing

Evaluation of the data occurs before the raw data is validated in the database. The purpose of this procedure is to ensure that the data being imported to the database was recording the correct location and that each parameter (temperature, conductivity, depth and salinity) is within acceptable limits of the instrument. This also confirms that the instrument is recording properly. The evaluation of data is accomplished through a series of reviews and checks. The results are reviewed by the technician performing the data download to spot any obvious errors and to confirm that the sonde is recording properly. After a final review the technician decides if the data is acceptable for final importation to the database for processing.

3.3.3 Data Validation

Once the raw data file is uploaded to the South Florida Natural Resource Center's Database (DataForEver), it is reviewed for outliers and instrument malfunctions. This is done by a comparison of the results of simultaneous data during dual deployment and post deployment checks. Using DataForEver database, the data are plotted to see whether the overlap in readings corresponds to the same pattern of increase/decrease in salinity. If the readings from the previous file match or follow the same pattern as the file that follows, the database uses the first reading of the deployed meter file to interpolate the drift that occurred between the first reading of the retrieved meter file and the last reading of the retrieved meter file. If the final reading of the previous retrieved meter file and the first reading of the deployed meter file do not match or follow the same pattern, the first (dirty) post-calibration reading is used to determine the linear interpolation. Once the data file is QA/QC'd, null values are entered into empty time slots. After 'Estimation Linear Interpolation' is completed, the data is validated.

The naming convention for each data file is as follows: LL = site/location number, NN = sonde identification number, M = month represented by a letter, DD = day, Y = last digit of the year. The naming convention ensures that all instruments can be tracked with their individual files to check for instrument error. The naming convention also allows each file to be individually identified later should the file be misplaced or lost and allows any site errors to be tracked through the data.

Data Validation performs two vital roles, it removes data that only the group collecting the data could identify as invalid, and it verifies a consistent data set that then can be made available to the public verified to within the specified parameters.

3.4 Measurable Results

All data is downloaded upon retrieval of the sondes. Raw data is stored on the NPS server, in hard copy, and on a CD. The raw data is saved through the Ecowatch program and then exported to a text file, readable without the Ecowatch software. These raw data files will be archived according to NPS standards using the proper file codes. All data will be available to project managers, lab technicians and the MAP program. All raw data is also retained on the DataForEver database as well.

Written quarterly progress reports are submitted by the project manager. The collected information are analyzed and annual reports are prepared. Cumulative annual reports include: (1) description of field activities and methods employed; (2) data provided to users; (3) analyses of the data; and (4) project results (in the form of tables, figures, and maps) and their interpretation as they relate to CERP and the adaptive management process. Annual reports will initially be in Microsoft Word format; the final version shall be converted to a .pdf file after approval and acceptance by the project manager.

The principal investigator will participate in development of the Annual AT System Status Report when requested and will provide 3 copies of a final report that will include at minimum the following: methods, results and statistical analyses of sampling efforts; conclusions and lessons learned (3 CD-Rom or DVD copies of raw data will also be included). Interpretation of results as they relate to CERP hypotheses from the MAP, the overall effort of CERP implementation, and the adaptive management process will be the major features of the final report.